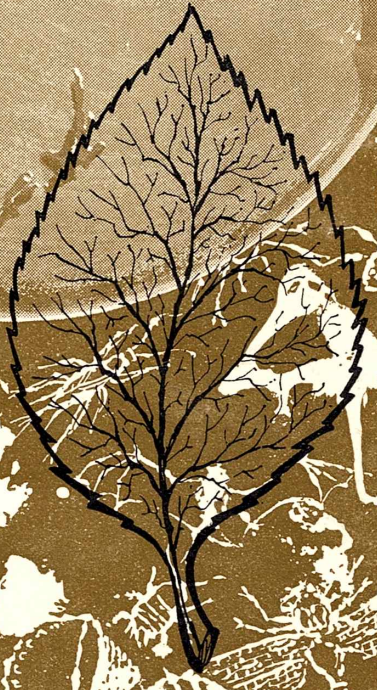
PLACES TO EXPLORE



Supplement No. 5 NATURE STUDY BULLETIN FEBRUARY, 1966

PLACES TO EXPLORE

A Series of Area Studies

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FOREWORD

This Supplement is a collection of articles and writings from the Nature Study Bulletin over the years. They have been selected for the purpose of assisting teachers with day trips to outdoor areas, but more particularly, with extended studies, covering a term or a year, of communities of living things in the vicinity of the school. As such, they should offer special help to Forms I and II teachers who are planning work on the biology section of the new draft syllabus.

The introductory suggestions on method, emphasise the importance of individual activity by children, of good planning before outdoor work is undertaken, of reconstruction of outdoor communities back in the classroom, and of good oral and written expression both in initial planning and as a sequel to activity.

Following these suggestions on method, a type community study, "The Pond", is undertaken. This offers opportunity for the consideration of the wider aspects of community studies, those which will link up with the teaching of concepts—inter-relationship, interdependence, equilibrium and change, energy and conservation. These more general aspects are included in order that the outdoor studies may be approached with some understanding and confidence. Concepts should be regarded as the outcomes of observation. If presented initially as principles from which to work, it is more than likely that the discovery idea, so important in all these undertakings, will be lost sight of and outdoor procedures become dull and uninteresting.

The various selected community studies which follow may be used by the teacher to suit his own school and district needs. No apology is offered for the large amount of space devoted to farm studies. Farms are part of the rich environment of New Zealand schools, both in country and outer city areas, and they are utilised all too little as a basis for our teaching and culture. If desired, the separate sections of farm study (the pastures, the crops, the animals, farm science), may be employed as separate area or science units.

Field Trips

There is a useful sequence of teaching methods by which outdoor work may be approached with some feeling of confidence and security. The preliminary training in observation essential to successful field work is best begun at the nature table. This can be followed by the more organised observation of team discovery (described in Bulletin Supplement No. 1). When children have become accustomed to these methods, a good foundation has been laid for interested participation in outdoor work on an individual basis. Not only so, but these basic methods become available for employment in follow-up work after trips, and the teacher is provided with suitable means of consolidating his field work.

Viewing these sequences in terms of the school year, one might commence in February with some joint planning by teacher and children of a nature corner, then begin to draw material from it for team discovery, and finally, hold out the field trip as an incentive for good observational work indoors. Field work might therefore commence in late February or early March. This season, and that of the late spring term, will generally provide the best opportunities for large-scale day trips; but field work, in the sense of team discovery outdoors, should proceed as an accustomed activity at all times.

If a trip is planned in terms of the expression which may accompany and follow it, most subjects in the curriculum will benefit from the day out. Steps in planning might be as follows:—

1. **An Introductory Class Discussion,** to set the stage and provoke thought and interest. It may be that new animals are to be met in an unfamiliar environment, e.g. seashore or pond animals living underwater. Try to excite the imagination by considering the strange conditions under which they live and some of the unusual problems they face, e.g. breathing, hiding. Challenge the class with the problems they may encounter in finding them, e.g. that of camouflage.

2. **Making Plans.** This is good fun. Give the children the feeling that they are planning both the trip and the ensuing activities. In this way, they become personally committed and their active co-operation is assured. Working in teams at defined stations will usually facilitate this; so **propose a team method such as the following:**

   (a) everyone do some "finding out" at all stations (discuss what we want to find out and have worksheets); everyone also to participate in the more creative elements of expression (e.g. a poem on seagulls or on the cricket's song),

(b) but provide for a group of "experts" to explore and report on particular stations, e.g. the high rocks, the rock pools; they will

—read up their speciality

—explore on the spot at the time of the trip

—discuss equipment needed for returning animals with a bit of their "home"

—reconstruct the "homes" on the nature table

—report their discoveries and exhibit their "finds" to the class

—write up and illustrate their own chapter for a class booklet on the trip.

3. **Discuss General Arrangements**—day, clothes, footwear, route, precautions, time schedule, letters to be written. Then divide into groups. *In Groups*—each group discuss its own arrangements for jobs, equipment, preparing "homes", setting up and maintaining these; and present a report under suitable headings to the class. This provides good practice in sorting out ideas and stating them clearly. Plan the individual jobs of team members largely with a view to reporting back later:

— *Leader*, who allocates jobs, sets the team to work, and introduces his team members when reporting back afterwards.

—*Events Reporter,* with a reporter's notebook, and such headings as: The Place; Our Task; How We Tackled It; Interesting Events; Interesting Remarks (direct speech).

—*"Homes and Inhabitants" Reporter,* who sketches or describes the different animal "homes" explored, the main "characters" found there, and how they were equipped to live there comfortably.

—*Finders or Discoverers,* with suitable equipment for searching and question-answer sheets to fill in on the spot.

—*A "Finds" Man.* Often it is wise to have some one person equipped with containers and responsible for returning carefully selected animals, with the requisite parts of their environment, for setting up later in the classroom. The rule should be one only of each, with the accent on conversation. "Homes" should previously be prepared in the classroom.

—*I Librarian, book man, editor* may be appointed, not only to search out books for facts and identification, but to provide a library of general reading, poems and illustrations for his group to work on.

4. **The Trip,** with its accompanying brief records by the groups; perhaps a few general records done by all if individual cyclostyled worksheets are available.

5. **Preparing Reports, in Groups. Sorting out Problems.** With a good lot of information now on hand and probably a keen desire to share it, brief the class first of all on the art of discussion.

   (a) Discuss our general objective in this part of the work.

      (i) To present a report (illustrated by material) to the rest of the class.

      (ii) To produce an illustrated booklet on our trip; say, to present to the headmaster or for our parents to read at home.

   (b) Make clear the part to be played by each member of the group in attaining these two objectives.

   (c) Detail the procedure for the groups:

      (i) A round table discussion (chaired by the leader; the main decisions recorded by the editor) to sort out interesting and important things or events we wish to report and illustrate. Also record a list of problems requiring further investigation or reading.

      (ii) With these main ideas as paragraph headings, work out a draft report and have this read to the group for criticism and amendment. Have in mind a reading public not on the trip. Organisation of material and lay-out are important, and will require assistance from the teacher.

      (iii) Rewrite the amended version for presentation to the class.

      (iv) Decide on the form of oral report to the class. Who will do what?

6. **Presenting Reports.** Now brief the class on the art of oral reporting, on chairmanship and order. The leader will state the general theme which has fallen to his group, then introduce each member as his turn comes to report. Choice of language, organisation of material, presentation, voice, and use of blackboard will be evaluated. An important function of this period will be the sorting out and enumeration on the blackboard of problems which require further study. These may be investigated by detailing someone to read or enquire, by continued observation of the living things set up on the table, or by formulating questions for team discovery.

7. **Team Discovery.** This method for observing and reporting is described in Nature Study Bulletin Supplement No. 1. It combines discovery with thinking together, panel reporting, class discussion and a teacher-directed formulation of report or conclusion.

8. **Creative Writing or Sketching.** More imaginative material than has emerged from the formal reportings may be prompted by suggestions of poems, paragraphs on exciting events, new ideas which are the result of discoveries, strange "characters" encountered, and the heightened feeling engendered by the atmosphere of places.

9. **Producing the Booklet.** The final production should go to press with the blessing of the class as a whole, after they have had the opportunity to add their suggestions. It will be handed to an editing committee which will include illustrators. A design for the cover and title page with appropriate titles for the chapters will be eagerly discussed by all.

Community or Area Studies

A piece of bush, grassland, swamp, farmland or seashore makes an admirable study extending over a term or even a year. Linked with nature table displays, taken from the area, and with expression in terms of reporting events and discoveries, it can produce a satisfying, coherent unit of experience. Planning can be undertaken on lines similar to that described for field trips, groups being responsible for particular areas, topics or themes.

Begin the year with a discussion on the idea of team work in exploring, and decide together how the nature table can be set up as a home base for investigating the area or district. Make use of the first period outside for the joint production, by groups, of a map of the area, each group at the same time returning something to the table. Then have groups working in their own areas, reconstructing these on the table, presenting formal reports orally and submitting written seasonal reports for inclusion in a booklet on the area. This is edited in the third term by a committee and put together as a culmination of a year's discovery and expression; the class itself voting on the most appropriate drawings and creative writings which are to be included as an expression of the feeling of the majority for their adopted area.

This is not an easy form of nature study and can readily degenerate into the mere cataloguing of separate things found in the area.

To prevent this, try to map the area to show both its living communities and the conditions of their livelihood (e.g., insects under rocks, in long grass). Add to this a reconstruction on the nature table of the communities themselves and of the physical conditions necessary to their survival. This makes for an understanding of the animals and enables some special studies to be made of their life histories. It can lead to science experiments, such as might be necessary, for example, to find the conditions for keeping stream or marine animals in an aquarium, or to ascertain the colours preferred by ants in a formicarium.

Following the construction of a map, a good method of working is to allocate part of the area, or a community, to each of several class groups, each group being responsible for—

(a) a diary of weekly events.

(b) a tally of inhabitants, with changes. In the case of plants, and sometimes animals, a population line (mapping along a line) or a picture-square (mapping on a square) are useful methods of ensuring serious work.

(c) some special studies of individual and typical inhabitants.

(d) a nature table display of the group's special area or community.

(e) an oral report to the class, either outside on the spot or indoors, illustrated by specimens, drawings or table exhibits.

(f) an illustrated written report based on discovered fact but written preferably as an account of a personal experience in discovery — a joint effort under a group editor, and including diary, special studies, tallies, personal experiences, etc. This can be part of a class book for interested reading by all on Our Area. From time to time it will be wise to gather the class together for special teacher-led studies, indoors or in the field, on themes of common interest, e.g., Communication in Animals, or on unit studies which all should cover, e.g., Rosette weeds in the Lawn or Joint-legged Animals. This latter, with many others, will be best treated as team discovery lessons.

It will be important to emphasise at the beginning that the means is at least as important as the end. The experiences encountered on the way, the methods by which discoveries were made, how each person set about his task, his feelings about his particular part of the work, impressions and attitudes are all as significant, and indeed make more interesting reading and more effective expression, than merely the end point of facts and knowledge. There should be every opportunity to consult books for guidance and help; but it must be remembered that individual growth and interest come from personal discovery. Material

amassed from books will remain bookish, but personal experiences in discovery, described by individuals in the simple sequences in which they experienced them, make interesting writing and entertaining reading.

Therefore, emphasise the diary of experiences and events, and encourage children to make this diary live in the very way in which the experience itself lived. Try to capture the thrill of the moment in the out-of-doors.

In the course both of outside work in the area, and indoor investigation with the nature table as a base, a considerable amount of reported material, along with sketches, will have accumulated throughout the study. If a class book is proposed as a culmination, it will be important to ensure from the beginning that these reportings, particularly the drawings, are executed with some finish, all of them on paper of the same size, for binding. The later work will then consist of:

1. A final visit or two to the area to observe changes in spring.

2. A conducted tour over the area to allow all individuals and groups to report in situ on the discoveries, and

3. Editing of the whole work and production of the booklet, each contributor signing his own portion, whether it be writing, poem, report, or sketch.

There will be an introduction ("Introducing Ourselves"), a report by the class reporter of how the class went to work, a map with an account of how it was made; reportings of field experiences and discoveries, of indoor developments and events, of special studies by individuals, and of themes investigated by the whole class.

These studies carry us immediately into the theme Interrelation and Interdependence which it is so important to grasp not only in relation to plants and animals, but also as a feature of life in to-day's world. It is suggested that the class be first introduced to this idea as a method of thinking about themselves and other living things. Reference to games teams, to expeditions of discovery, to teams of scientists, and to the class itself as a working unit, will carry the idea home. The well-worked phrase, "All flesh is grass", could then take discussion a stage further to confirm our own dependence upon plants and animals. The Balance of Nature and Biological Control are two important talking points, both admirably illustrated in the ecology of settlement and of pest control in New Zealand. This should link readily with plans for the study of communities with their interrelated plants and animals.

D. Beggs

How to Study a Community

Part I: Trip to a Pond

E. and M. Stevenson

Ecology is the study of living things in relation to their environment. The pond is a specific example of a community which can be studied by a class and a teacher, in such a way that all the facts and principles of ecology fall into place. There are three reasons for choosing a pond:

1. There is often one close at hand.
2. The pond forms a community that has reasonably well-defined boundaries.
3. This is a community which has similar features throughout New Zealand.

Our aim in this article is to give general principles that will apply to ecological work of this nature in most parts of the country. We will then use the example of "our" pond to draw together all the "theories" and show how the following take their place in the community:

1. Collecting and transferring energy.
2. Feeding levels and food chain.
3. Niches, i.e., places in the food chain.
4. Chemical cycles.
5. Needs of communities.
6. Adaptations of plants and animals.
7. Seasonal cycles.

These may all be placed under one heading, i.e., the interrelation and interdependence of plants, animals and the physical environment. Thus by taking one area as a sample community we hope to show how the principles of ecology appear in nature and also how the teacher with the aid of *nature* can bring these principles within easy grasp of the child. We have broken the work up into:

(a) approach to a study of this community (teacher preparation),

(b) teacher and class at work.

(A.) Approach to Study

Any leader of a successful expedition of exploration and discovery must be well-prepared. As teacher of your class and

therefore the "leader", it is essential that your work for this study should be carefully organised. The following are the chief steps to be made in preparation for an ecological study of a pond:

1. **Select a suitable pond**
   (a) as near the school as possible.
   (b) it must be safe to work in.
   (c) it should be easily accessible.
   (d) if you have a number of ponds to choose from, select the one which contains the largest animal population.

You MUST examine the pond for snags and danger points as well as to discover the areas most suitable for study and collection.

2. **Prepare collecting and retaining equipment**

Examples of collecting and retaining equipment are presented on the illustrated pages. The children of your class will be pleased to help in the making of simple box terraria for frogs, and other types of containers for aquatic animals.

3. **Obtain References**

Build up, from the school library and from books which the children will be able to bring from home, a collection of books about pond life, the life histories of pond animals, how to keep an aquarium and how to make a pond at home.

(B.) The Teacher with the Class—Interest

In introducing the topic and developing the children's interest in it, make them feel that it is *their* study, not something which has been thought out completely by someone else. It does not pay a teacher to set himself up as a final and expert authority, especially in an area as difficult as that of ecology.

The child's enthusiasm is of paramount importance in making the study fascinating and worthwhile.

The work that the children are going to do *is* new. The way of studying a community is a way that has not often been attempted in primary schools in the past. In itself this adds interest for children and teacher. Biologists could be discussed, perhaps with the aid of autobiographies, to show that work of this kind is interesting if the worker is prepared to find out small details and put them together to give large results.

Before the Trip

Before we set out on our exploration we need to discuss the background to the work, or in other words answer the query, "What is this all about?" Here the teacher can begin to lead the

child's mind into the beginning of an appreciation of ecology. This may involve a talk from a forest ranger (a wild-life officer) on the principles of ecology as practised in conservation. However, before the pond is visited is not the time to go into lengthy discussions of e.g. the nitrogen cycle. Such discussions can wait until the child has a knowledge of the community and can apply this to the mechanics of chemical and energy relationships.

Communities, habitats and niches could be discussed so that even on a preliminary visit to the pond some of the plant and animals will be seen to fall into their categories, and later, discussions about the pond, its inhabitants and their life requirements, will begin to have meaning. Do not bore the children with technicalities.

1. The First Visit by the Class

This visit is to whet the appetite, to prepare for the "great" study, and it should be treated as such. With the idea that they are not to ruin the pond for future trips, the children should be allowed to explore the pond. Let them *find out* where it is boggy and where the tadpoles are. The teacher may make suggestions and indicate interesting areas for discovery but let the children explore.

One way of arousing interest is to make exploration competitive. Each group, pair, or person, is asked to find e.g. 2 insects, 1 tadpole, a 6″ long piece of pond weed, 2 different grasses, 3 water beetles. Ensure that the animals are kept in a suitable container and returned at the end of the competition.

This is also the time to make the master maps or at least to take measurements and directions for it. "Yard-steps" will suffice but tape measures are preferable as this is an exercise in both arithmetic and geography and should be treated as such. How deep is the pond? Where does it overflow? These things will have a later bearing on the study and need to be "discovered". This is the children's exploration because to all intents and purposes the teacher might never have been here before; but of course the wise teacher is well prepared. Don't forget old clothes and old shoes are necessary because no matter how careful you are, someone gets wetter than they should. All finds can be put into portable pools for the purpose of display and then as this is a preliminary visit, put back where they were found.

Back at School

Now the class really put on its thinking caps—how are we going to find out anything in the ecological sense about the pond.

At this time it is decided how the study is to be made—in groups, pairs or singly. Are all going to be collecting animals? How are we going to study plants around the area?

Now that the children have seen the pond and have been able to identify and discuss some of the animals and plants, they are in a position to plan their project *with* the teacher.

Now is the time to remind them of earlier discussions about conservation: What do animals and plants need in order to live, and what are other important ecological principles which may have been discussed?

Our aim is to explore the community to discover how nature practises conservation, how energy is transferred, how and where organisms obtain their food, which animals and plants are found in particular habitats and how these organisms are adapted to their habitats.

Base Camp

Before going back to the pond, thought must be given to preparing for the reception of animals and plants that are brought to the class for further study. This is most important for if we are to develop an ecological approach we must practise our beliefs and not just collect quantities of animals indiscriminately. By setting up equipment before going on our trip, we can ensure that we collect only sufficient for our facilities. Remember that plastic bottles and jars are preferable to glass.

COLLECTING AND RETAINING EQUIPMENT

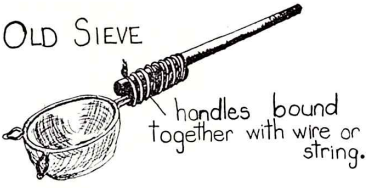
(a) Collecting Equipment

The equipment used for the collection of animals will largely depend upon the types of animals which are present in the pond and around it. The equipment shown here will serve most purposes.

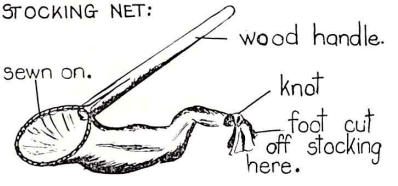
COLLECTING EQUIPMENT

Tadpoles, Water Mites, Water Beetles and all other Swimming and Floating Animals

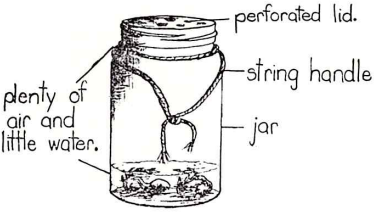
(1) **An old sieve,** obtained from the kitchen. If pond is deep, fasten an extra handle of wood, wired or bound on to the sieve handle.



(2) **A Stocking Net**
Materials: 1 old nylon stocking, wire, wood for handle.
Cut off foot of stocking, tie end in a knot. Make loop in wire and sew top edge of stocking over it. Bind wire on to handle with either string or flexible wire.



(3) **A Jar.** A 1 lb. jam jar with perforated lid is ideal. A string handle will make it easier to carry. Place animals in jar with some pond water.



Frogs, Flying Insects, Butterflies, Moths, Dragonflies

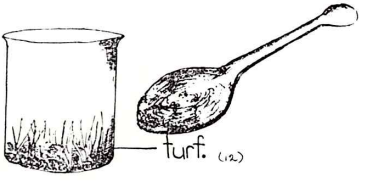
(4) **A Wide Mouthed Net**
Materials: An old lace curtain, or tulle, or net material.
Make up in same way as for stocking net.
If catching frogs, submerge net in water and bring up under frog.
For flying insects, use long, sweeping movements. An old tennis racquet handle makes a very light, strong handle.

Frogs

(5) **Large Jar** with a perforated lid is needed to transport the frog from the pond to school. A string handle is needed. Fill up to 2″ water for a large frog and up to 1″ for a small one.

Small Animals and Insects on the Ground

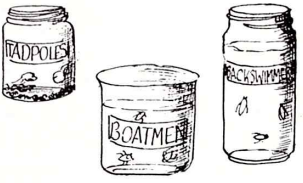
(6) **Jar and Old Spoon**
Use the spoon to scoop up the animals and place in the jar, which has ½″ turf in it.



If the animals captured are to be studied at the pond before taking them back to school for observation on the Nature Table, it will be necessary to have available some form of display container. Choose from the following types to suit your particular need.

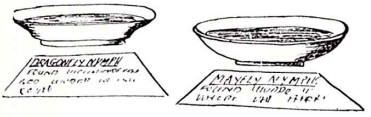
Jar

Do not mix animals. Place one type in each jar, all water boatmen together; all tadpoles together, etc. Each jar may be labelled if necessary with the name of the inhabitants.



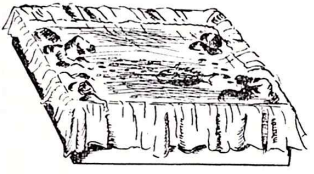
Soup Plates

These provide a light background against which to study the animals and plants. Again, separate the species.



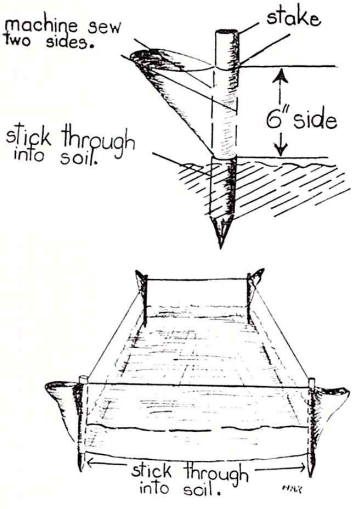
Box Aquarium

Use a shoe box, or chocolate box, and line with plastic, stapling or sticking down the plastic around the lap-over on the outside.



Portable Pond

See diagram. Use a square of plastic as thick as possible, about 2′ square. Sew with machine at corners as shown. Set up at pond, pushing stakes through as shown.



2. "Back We Go"

Now we are ready to revisit the pond. We have benefited from mistakes made last time. The children know what they are trying to find out. This is where good preparation is essential. If the children are interested and know what they are required to do, they will learn to use their eyes to good advantage.

If the area is sufficiently large to allow of working in pairs this grouping should be used. According to whether you are to make one trip or a few small ones, these pairs may be assigned certain areas of investigation. A few such areas to investigate would be:

(a) weeds growing immersed in the pond.
(b) weeds with roots and part of stem in the water.
(c) boggy-rooted areas.
(d) dry-rooted areas.
(e) animals in deep water.
(f) animals amongst weeds (1, 2, 3, 4).
(g) animals near weed-free edges.
(h) animals above pond.
(i) animals in clear earth area.
(j) animals on bushes and shrubs in the surrounding area.
(k) weeds and animals in, on, or around, submerged logs, etc.

It must be noted though, that each pair should have the opportunity of working in each area otherwise it will be difficult for them at a later stage to understand the community as a whole.

First of all, each organism may be classified by referring it to its habitat and niche (the place where it lives and the place in the food chain). Habitat will be the easiest and niche, in the case of animals, the hardest to define. For example, how do we distinguish carnivore or omnivore? This is difficult to decide unless we actually see the animal eat something. If an animal can be kept alive in the classroom we will have more opportunity of identifying its food, or of testing the truth and accuracy of statements relating to foods found in books.

While working at the pond, each group should have some sort of portable pool, e.g. an enamel oven-dish. Into the pool go all the organisms found. Here the children may study their "finds" at leisure under simulated pond conditions.

Identification will be a large part of the work. It is suggested that *sample* plants be labelled so that they may be recognised and related to a habitat, then collected in a plastic bag and when taken back to school, identified.

However, just to know that an animal or a plant is present in this community is not enough. Is the plant or animal an important member of the community or an alien? Counting animals will help us to decide this. It must be emphasised that this is by no means necessary for a good study of a pond. Counting may link well with

arithmetic, but should be attempted only if the children are keen. How are we to count the animals and plants which are present? Except for plants (which stay still) it is obvious that we cannot count every single organism. We can get a guide, however, by taking samples from various parts of the pond. Remember though that this results in an estimate of population and would not be accurate.

An area at the edge of the pond about 1 ft. long, could be marked off and extended out into the pond for 1 ft. (Four pegs to mark the corners.) The children could count where possible the numbers of organisms in that small area. This would give a ratio of the numbers of one animal compared with the numbers of another. If this is done in different places, an overall picture will be obtained. Larger animals, fish and frogs, can be noted as they are seen.

All sightings may be noted, if desired, on a class record chart. Later, these totals will give approximate ratios of abundance. Another way is to liberate several marked animals at the point of capture. After they have had time to mix with the population again, another collection is made and the ratio of marked to unmarked animals is obtained. The following formula will give an estimate of the population size in the pond.

a = total number of animals captured (second time)
b = number of marked animals in sample (a)
c = number of marked animals released (first time)

$$\text{then population} = a \times \frac{c}{b}$$

How to map the Plants

To obtain a picture of the plant population we may use the picture-square or quadrat method. In this method we mark out a yard square with pegs or sticks or yard rules. Then we may do any of the following:

(a) Count the number of different types of plants.
(b) Count numbers of each species.
(c) Map the area to show where each species of plant is growing.
(d) Map to show distribution of a species that is dominant.

In this picture-square we may also include the number of insects found on the plants.

Another way to show the distribution of plants is to take a population line (transect) from the pond up the bank into the surrounding hedge or long growth. Then work slowly along the line plotting the plants found there. The plants may be drawn in on this line when it is transferred to paper either in section to show their relative heights and position, or in plan as seen from above. When making these diagrams in the field, the child will come across innumerable specimens that he cannot identify. These should be given a number or a letter and identified later

at school. Plants can be labelled easily by slipping a piece of paper, with a slit, over the stem.

Several picture-squares and population-lines can be taken in different places so that random samplings are made. Not much purpose would be served by having each square close to the next one. By the time the class has finished this part of the study they should have some knowledge of the following:

(a) The topography of the community.
(b) Types of animals present.
(c) The approximate ratio of abundance of each animal.
(d) Species of plants present.
(e) Distribution of the plants.
(f) Habitat of the plants and animals.
(g) Observations as to the niches of the plants and animals.
(h) Observations as to the habits of plants and animals, e.g. growth, movement, protection, camouflage.

Important Note: Both of the above methods — that of counting, and that of the sample square or population line — are recommended only for the more interested teacher and class. The routines involved in them could well detract from the enthusiasm of the class. This must at all costs be preserved.

Conservation

We are trying to develop an understanding of conservation and so it will certainly not be useful if we up-root areas of plants and needlessly slaughter or maltreat the animals found.

3. **Back in the Classroom**

Several important matters must be attended to directly after the trip:

(a) **The Map**

The map must be filled in with appropriate details—the position of the working parties, where animals and plants of particular interest were found, position of picture-squares and population-lines made in the area. These must be drawn in their final form before the meanings of any symbols are forgotten. Pictorial representations of the members of the community will mean more to children than masses of stark symbols.

(b) **Written Work**

Any written records must be completed quickly. Do not allow the children to leave any work uncompleted.

(c) **Animals**

The animals must be set up in their "homes" in the classroom in the equipment prepared by the children. Question cards (see "A Handbook of Nature Study" by D. Beggs, for types of questions to use) and notes on feeding may be pinned or stuck on to the containers by the group responsible for that particular animal, i.e., the animal that was found in their area.

Tadpoles and Aquatic Small Animals and Insects

(a) **Indoor Pond.** Materials: 1 large cardboard box, cut down to 6″-7″ deep; 1 large sheet of polythene or plastic. Place the box in permanent position. Press polythene into box after lining box with white paper. Make sure polythene fits snugly all round sides and corners of box. Staple polythene on round TOP edge of box. Set up as pond with the plants and animals. NO feeding will be necessary.

(b) **Indoor Pond.** Materials: An old-type desk with the lid removed. Line with polythene or plastic in the same way as for (a) above.

(c) Indoor Pond. A tyre pond. Place a car tyre flat in a permanent position on light coloured cardboard or paper. Line the tyre with polythene, and tuck polythene under outside of tyre.

Small Frogs and Other Small Animals except Slugs and Snails

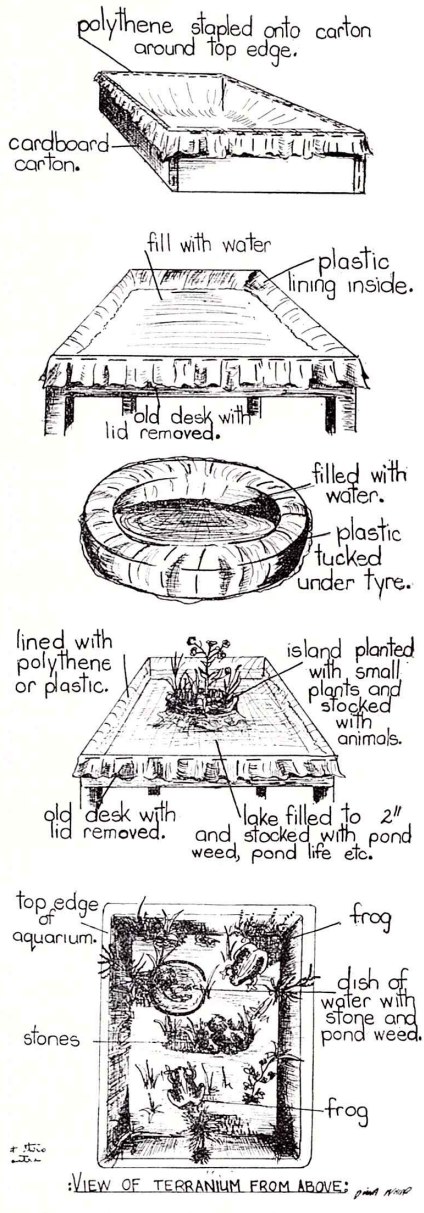
(d) **Lake and Island.** As for (a) and (b). Make the island, on which the animals will live, as follows:—

(i) Make a plasticene retaining wall, round or square, or irregularly shaped, about 3″-4″ high and 6″-8″ across.

(ii) Place this "wall" in centre of prepared pond. Seal plasticene on to plastic to seal watertight. Fill in the island with ½″ small stones, then with sandy soil, firming it well.

(iii) Plant with small plants (from the home of the animals).

(iv) Fill lake with water up to 2½″ deep (from the pond) and introduce the animals into water, and on to island.


polythene stapled onto carton around top edge.
cardboard carton.
fill with water
plastic lining inside.
old desk with lid removed.
filled with water.
plastic tucked under tyre.
lined with polythene or plastic.
island planted with small plants and stocked with animals.
old desk with lid removed.
lake filled to 2″ and stocked with pond weed, pond life etc.
top edge of aquarium.
frog
dish of water with stone and pond weed.
stones
frog
VIEW OF TERRANIUM FROM ABOVE.

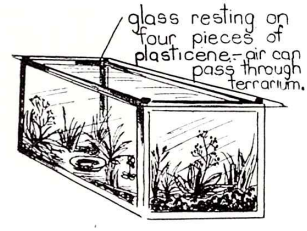
Frogs

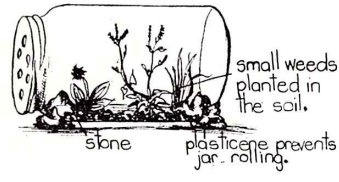
(e) **A Frog Terrarium.** Materials: One large aquarium (for large frogs). One soup plate or deep saucer. Turf from sides of pond. 2 large or 3 small frogs. One sheet of glass or fine wire netting or gauze to cover aquarium.

(i) Place aquarium in permanent position. Line with fine gravel.

(ii) "Plant" with turf pieces, placing the soup plate or saucer in position at one end, and filling it with water.

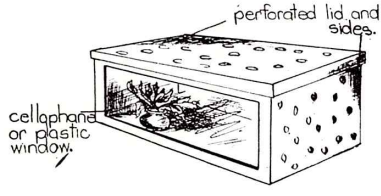
(iii) Water the turf to make it moist right through, not soggy.





Lizards

Lizard Terrarium. Materials: A preserving jar with perforated lid. Plasticene. Stones. Soil, small weeds. Make up as shown.

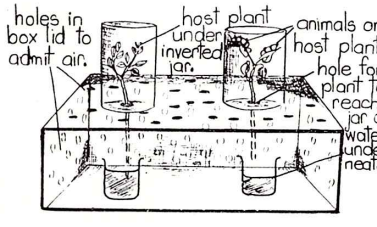


INSECTS, SMALL ANIMALS

Caterpillars, Snails, Slugs and any Insects except Crickets which will eat through the Cardboard

(a) **Insect Box.** 1. Materials: A shoe box, a piece of clear plastic. Cut a "window" out of the box as shown, and replace it with the plastic or cellophane.

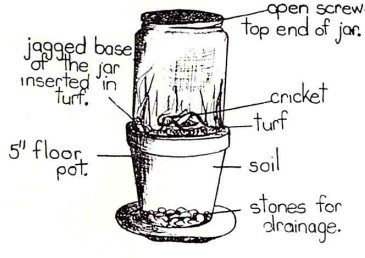
(b) **Insect Box.** 2. Materials: 1 shoe box, 2 preserving jars. Make up the box as shown.


holes in box lid to admit air.
host plant under inverted jar.
animals on host plant.
hole for plant to reach jar of water underneath

(c) **Cricket Cage.** Materials: One 5″ flower pot or large tin; 1 preserving jar or vinegar bottle, etc. A piece of turf, soil and drainage stones to fill flower pot.

(i) Remove base of jar with hot water. Set up as shown.

(ii) Place 3 or 4 crickets on the turf. They will not escape as long as food is available. They will mate, lay eggs, and the young will emerge.



This is a simple guide to the feeding of the more common animals we shall encounter in our study of the pond.

Frogs

Small worms, must be alive when given to the frogs, also live flies.

Tadpoles

In the early stages of growth (after age of 2 weeks) feed on goldfish food (it will provide the proteins necessary to the normal growth of a tadpole). While legs are developing, feed on small pieces of fresh meat as well as on the fish food. Tie the meat pieces on to a piece of cotton and suspend it in the water. The unused or old meat is easily removed in this way.

Water Beetles

Feed with any small aquatic form insect life.

Water Snails

These must be provided with water and plants from the pond. No other feeding is necessary if these are provided.

Hydra, Daphnia (Water Fleas)

As for water snails. The food necessary for them will be collected with the weed, mostly invisible to the casual observer.

Water Boatmen

As for hydra and for daphnia.

Cricket

Turf. Any fruit scraps.

Lizards

Water, honey or sugar and water made into a syrup.

Caterpillars

The plant on which they were found.

Slugs and Snails

Plants on which they were found, or silver beet or cabbage leaves.

Slaters

Decaying leaf matter.

Bullies

With small pieces of worm after one fortnight, thereafter twice weekly.

(d) **Plants**

If any of the children are making a class book of pressed plants of the area, the specimens should be pressed immediately (before they wither) between sheets of newspaper, and weighted down with heavy books. Place a sheet of plastic between the top newspaper and the books on top to prevent any moisture from the plants entering the covers of the books and causing mould to develop. It is essential, too, that every plant brought back to

the classroom be identified, and whether it is to be pressed, or grown in the classroom, each should have its name-tag firmly fixed to it. If the plant cannot be identified, the finder might make up a name for it until the correct name is found.

Pressing Plants

It is appropriate here to give a few hints on pressing plants. The easiest and most successful procedure is as follows:

(a) Collect, where possible, a whole, fresh plant (including the root). If the plant is too large, collect a reasonably small piece of the plant with flowers, leaves and stalk to press and, pulling the plant up, draw the root system. This drawing can then be included on the sheet with the pressed plant.

(b) Identify each plant.

(c) Arrange each identified plant, with naming tag securely affixed, between two sheets of newspaper; place several layers of paper on top, then place the next plant in its fold of paper and so on until all the plants have been treated in the same way. The extra thicknesses of newspaper ensure absorption of plant moisture, and each plant is pressed evenly. It is advisable to change the newspaper after one week to prevent mould developing and to ensure that the plants are drying out properly.

(d) After 3-4 weeks the plants should be quite dry, flat, and ready to mount. Mount one species to a page on firm, white paper and affix with tape. Information included on the bottom right-hand corner of each sheet should be as follows:
Name of plant; Habitat; Locality; Date.
Gather all the sheets together into a folder, or better, place the sheets in a box.

4. **Further Reading**

The children should be given the opportunity to read as much as possible. The books in the nature table library will provide material.

5. **Written Expression**

In addition to the actual recording work, encourage the children to write stories, plays and poems on the life in the pond. Poems about water animals, frogs, tadpoles and dragonflies, have been written and these may be read by the children to show them "how to go about it", although the natural stimulus of the animals themselves will be the starting point. A class book of poems may be built up and perhaps presented to the class in the form of a "radio broadcast", the "poet" reading his own work. It is obvious that speech-consciousness may be developed as the

class criticises and comments upon the poem and its presentation "over the air". The "broadcast" may be made using the school speaker system with permission of the head teacher, or by making a tape recording of the poem as read by the "poet" and playing the tape back to the class.

6. Art Records

There is ample scope for children who enjoy painting and drawing to build up murals depicting pond life, or to paint or draw their individual pictures. The following titles may be suggested to the children as subjects for pictures, etc.:

"The Struggle for Life" (from a knowledge of food chains)
"Under Water Fight" (food chains again)
"Water Plants"
"The Pond at Dawn"
"The Dragonfly"
"A Water Beetle as seen by a Water Mite"
"A Tadpole's Eye-view of the Pond"
"Frogs Galore!"
"A Water Flea's Kingdom"

Pattern and texture drawings might be made using the following as bases:

(a) the water plants
(b) frog colouration
(c) water boatmen
(d) fish shapes
(e) water beetles
(f) dragonfly wings
(g) body shapes of tiny animals as seen under a hand lens, e.g., hydra, daphnia (water flea), water mites, etc.

Mobiles—these might be built up, using the shapes of pond animals as models.

References for the Children

Field Notes for the Fresh Water Naturalist — Dickinson, Dominion Museum.
The Pool—School Publication Bulletin.
Weeds of New Zealand—Hilgendorf, Whitcombe & Tombs.
Pasture Plants and Grasses — Hilgendorf, Whitcombe & Tombs.
Native Animals of New Zealand — Powell, Auckland Museum.
Pond Dwellers No. 2.
Aquaria No. 1—F. M. Haworth, Natural History Series.
Observers Book of Pond Life—John Clegg.
Life in Fresh Water—E. S. Brown.

Part 2 — Interpretation of Findings

In our first article we described a trip to a pond. It is one thing, however, to discover how many buttercups are growing on the bank of a pond and another to obtain a true picture of an aquatic community. In this article we intend to discuss the means which we have used to gain some understanding of community relationships in the area studied.

Looking at the Animals

The first article suggested that a class map be made of the pond. It also suggested methods of mapping the plants. By sampling the animals (and plants) in various parts of the pond we can fill out the picture of the map by adding some population figures for the different pond "homes". If this is done in the different seasons, interesting results may accrue.

The tables which follow (p. 27) show the numbers of different animals which our samplings brought to light, the "home" or habitat which we noticed was characteristic of each, the "profession" or niche which we observed or conjectured to be habitual, and the various adaptations by which each was suited to such a habitat or niche. Try to help children to discover these "homes" by observation at the pond and the "professions" by watching the feeding habits of the various animals as they are kept and fed in aquaria.

Looking at the Plants

Like animals, plants are adapted for living in special places. These adaptations are many and varied.

Speaking generally water plants have the following adaptations to their environment:

1. The epidermis (or outer skin) is thin in all parts of the plant for it is through this that the minerals and gases dissolved in the water, are absorbed.

2. Therefore, the roots are quite often absent, or if present, merely serve to anchor the plant. Root hairs are generally absent.

3. Water conducting tissue is no longer needed since every part of the plant receives water directly. The fibrous bundles in the stems, and veins also, are therefore much reduced or else entirely wanting.

4. Water gives support so that fibres and other hard tissues are generally lacking.

5. Large air spaces are developed in all parts of the organism, in the first place to float the plant, and secondly, to conduct to the submerged tissues the air needed for respiration.

6. The submerged leaves are usually long and strap-shaped as in vallisneria, narrow and arranged in whorls as in the water-starworts, or divided into numerous fine threads as in the water milfoils. In this way, damage by running water is obviated. They have chlorophyll in their epidermis and are without stomata or breathing pores. Leaves which float on the surface are usually entire and oval or round, and have their stomata on the upper surface.
7. Water plants usually grow rapidly, branch freely, and reproduce enormously by vegetative means, usually by the decay of the older tissue which sets the young shoots free, as in the pond weeds and water-lily.

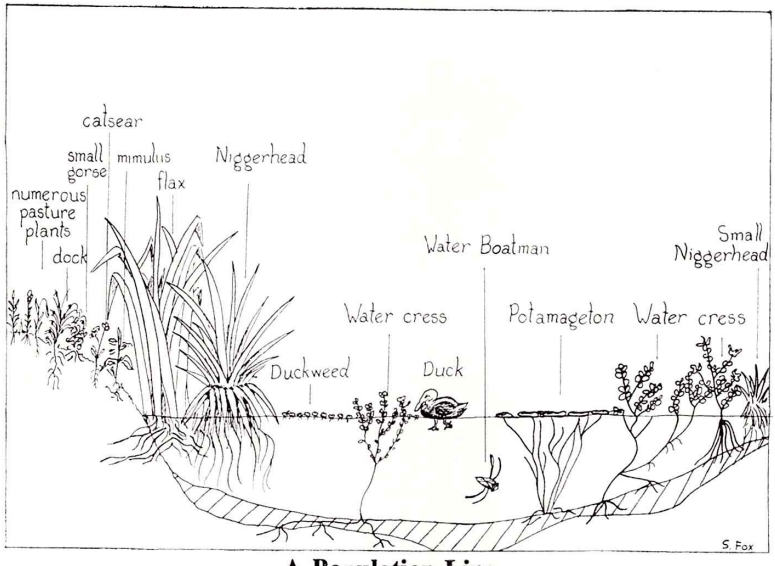
Most of these adaptations can be seen and examined by the children themselves. Where possible, give the plant or animal conditions where the particular adaptations can be seen to the best advantage.

Experiments with Pond Water

To extend this work, simple experiments could be carried out to show that there is air in water and that the water also contains small particles of soil, which eventually will settle and slowly decrease the size of the pond.

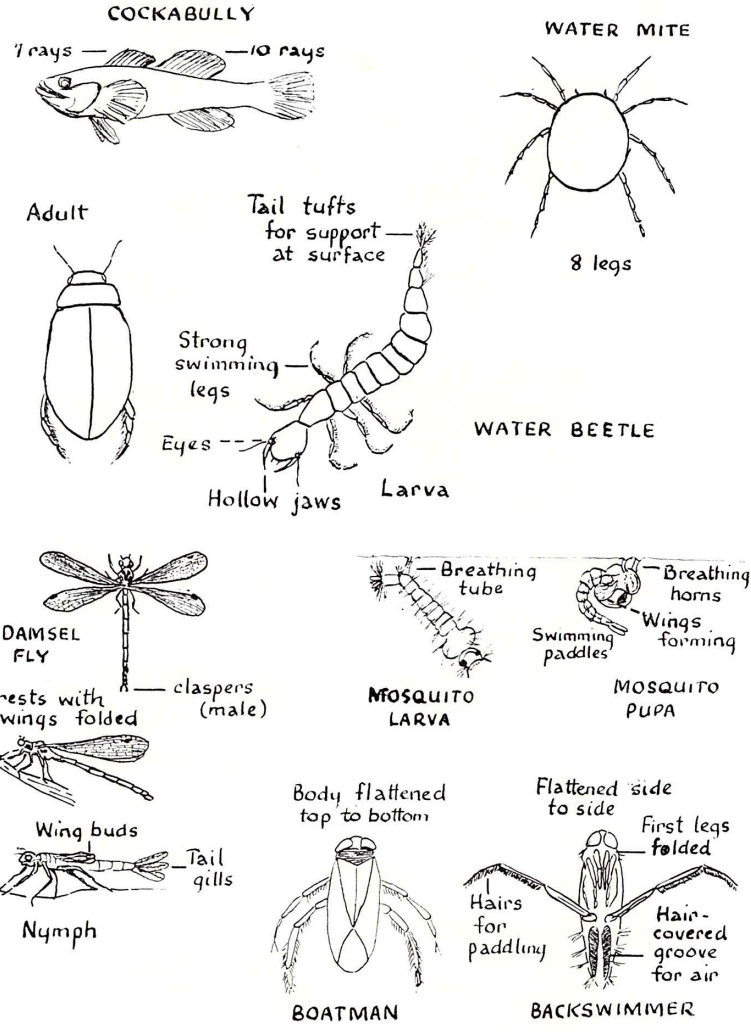
Pond water contains:

1. **Air**—Heat a small quantity of pond water gently. Bubbles of a gas will soon rise. This is probably air, containing carbon di-oxide and oxygen in variable proportions.
2. **Soil**—Evaporate all of a small amount of pond water and you will have left behind, a residue of soil.



A Population Line

Some Pond Animals



POND ANIMALS FOUND AND THEIR PLACE IN THE COMMUNITY

NAME	HABITAT	NICHE	ADAPTATIONS	ABUNDANCE
Potamopyrgus	On weeds and stones. Any suitable browsing surface	Herbivorous. Alga feeder.	Shell with bristles. Powerful "foot"	Very abundant 1164.
Waterboatmen.	Amongst weed especially. Found everywhere else in pond too.	Herbivorous. Feed on algae and water plants.	Legs flattened and with hairs as for Dytiscids.	Scarce 5
Bullies.	Mostly in shallow water, where temperature is higher.	Carnivorous, feeding on potamopyrgus, and aquatic animals.	When disturbed, dart to deeper water. Protective colouration.	Not scarce 9
Stick caddis (larvae) Sandy cased caddis (larvae)	Attached to weed and floating board.	Herbivorous. Eat the pond plants and plankton.	Draw back quickly into case if disturbed.	9 5
Dragon fly nymphs	In the mud at the bottom of the pond.	Carnivore. Feeds on any smaller water animal life.	Strong "mask" (jaws) for catching food. Moves by jet propulsion.	Scarce. 2.
Dytiscid beetles. (Large water beetles.)	Swimming freely in shallow water.	Fiercely carnivorous. Feeds on snails and insects, small fish etc.	Legs are flattened—act as oars.	2 large. 8 small.
Bryozoan colonies.	Attached in colonies to smooth stones.	Carnivorous. Feed on zoo-planton (i.e. animal plankton)	Live in colonies in protective network of tubes.	8 colonies.
Hydra.	Attached to floating weed near surface.	Carnivorous. Feeds on zoo-plankton.	Like the sea anemones, has tentacles with stinging cells to trap its prey. Moves by somersaulting.	70
Backswimmers.	Found amongst weed rather than in clear water.	Carnivorous. Feeds on smaller aquatic animals.	Oar like legs. Carries air in a film on underside of its body.	28
Damsel fly adults.	In vicinity of pond. Red and blue. Some were mating. No nymphs in pond.	Carnivorous. Preys on other small insects.		Very abundant 70.
Muscovy Ducks.	Roosting platform at shallow end.	Filter feeders. Seive the mud for food. Omnivorous.	Webbed feet.	5

COMMON POND ANIMALS—IDENTIFICATION and ADAPTATIONS

prepared by John Charteris

NAMES	FAMILY	IDENTIFICATION	BREATHING	LOCOMOTION	FEEDING	LIFE HISTORY	WHERE TO FIND
Water Boatman	Insect: Bug family. Insects in this family have long beak-like sucking mouth-parts.	Can be mistaken for a back-swimmer. Swims back uppermost. Is flattened from top to bottom. Tail is rounded.	Air for breathing is taken into a space on the back between the wing covers and the hind wings. The insect rises to the surface pushing the tip of its tail above the water to obtain a coat of air that envelopes the whole body. The air is held in place by many fine hairs and absorbed into the breathing organs or spiracles situated along the abdomen inside the outer edges of the wings. By sitting on the bottom and moving its long legs to create a current of water around the body it helps oxygen to diffuse inwards and waste carbon dioxide outwards. In this way the boatman can stay under the water for long periods.	The two hind pairs of legs are suited for swimming. Moves quickly over the bottom of the pond with a peculiar half swimming, half running motion.	Scrapes oozes off pond bottom and plant stems with front pair of legs, and sucking with beak-like mouth-parts.	Eggs are fastened to submerged objects with a sticky substance. Eggs hatch in about 2 weeks. Nymph resembles adult except for under-developed wings. Moults to reach maturity.	Use a pond net and sweep over the bottom of the pond or along any steep sides. Does not move in open water.
Back Swimmer	Insect: Bug family	Swims on its back. The wing cases are a silvery colour. The body, flattened sideways, is pointed at the posterior end. Usually about $\frac{1}{2}$" long.	There are 2 hair-covered furrows running down each side of the abdomen. When the insect breaks the surface the hairs open out, flat on the surface, and air is allowed to enter the grooves. On submergence the hairs close over the furrows and are fine enough to trap the air inside. The spiracles or breathing pores are situated in these two furrows so that the insect can breathe under the water.	Swims with powerful strokes of the last pair of legs as though it were rowing. These legs are fringed with hairs that are stiff and erect as the stroke is being made and flattened on the return stroke. Wings are well developed and it will fly on hot days by leaping off the surface. This is how it gets from one pond to another.	Preys on many aquatic animals taking prey larger than itself, catching by pursuit. Has typical bug-type, beak-like mouth which it plunges into its victim. The body fluids of the victim are sucked out.	Mates under the water in spring. Eggs laid singly in submerged plant tissues. Hatch about 3 weeks later. Young resemble adult but have short wings and are smaller. Maturity is reached through a series of moults.	Swims in open water looking for prey. Found at all times of the year but much more plentiful in warmer seasons. Scoop out with pond net.

NAMES	FAMILY	IDENTIFICATION	BREATHING	LOCOMOTION	FEEDING	LIFE HISTORY	WHERE TO FIND
Mosquito a) Larvae	Insect: Fly family. Insects in this family have only 1 pair of wings instead of 2 pairs as in other flying insects. Club like structures called "halters" or "balancers" replace the rear wings. These are thought to be organs of balance.	Hangs head downwards from the surface. Remains motionless if undisturbed. Long body with a large thorax and head region. Fine hairs protrude all over the body, called wrigglers.	From the last segment there protrudes a tube that has fine hairs on the end which flatten out on the surface of the water allowing oxygen to pass into the body to be dissolved in the blood. These fine hairs, by spreading out over the water's surface film, hold the larvae at the surface. When the hairs are closed to stop air escaping the larvae sinks.	Swims actively through the water by rapid contortions of the body—gets the name "Wriggler" from this action. There are special organs on the last segment which are said to help swimming and steering.	Small hairs around the mouth by constant motion, drive water and microscopic animals into the mouth.	Female lays eggs (100-300) on the surface arranging them into a small raft with her hind legs. Eggs hatch 1-5 days depending on water temperature etc. Larval stage lasts 1-2 weeks during which time it moults about 4 times. At last moult it becomes a pupae for a few days then adult emerges. Over winters as adult.	Breeds in thousands in dirty, stagnant ponds. Likes pools in rubbish dumps and other such places. Water troughs favourite place.
b) Pupae		Hangs from the surface head uppermost. Has a large rounded head with 2 small horns situated at the back of the head. Called "tumbler".	Unlike the larvae the pupa is lighter than water and always rises to the surface if not swimming. It pushess the two horn-like breathing tubes up into the air. Water cannot enter the tubes because of fine hairs lining the sides.	Has a pair of flat appendages on the last segment of the body which are used for swimming. Gets name "tumbler" from tumbling action whilst moving through the water.	Pupal stages do not feed. Inside the body changes from larva to adult.		

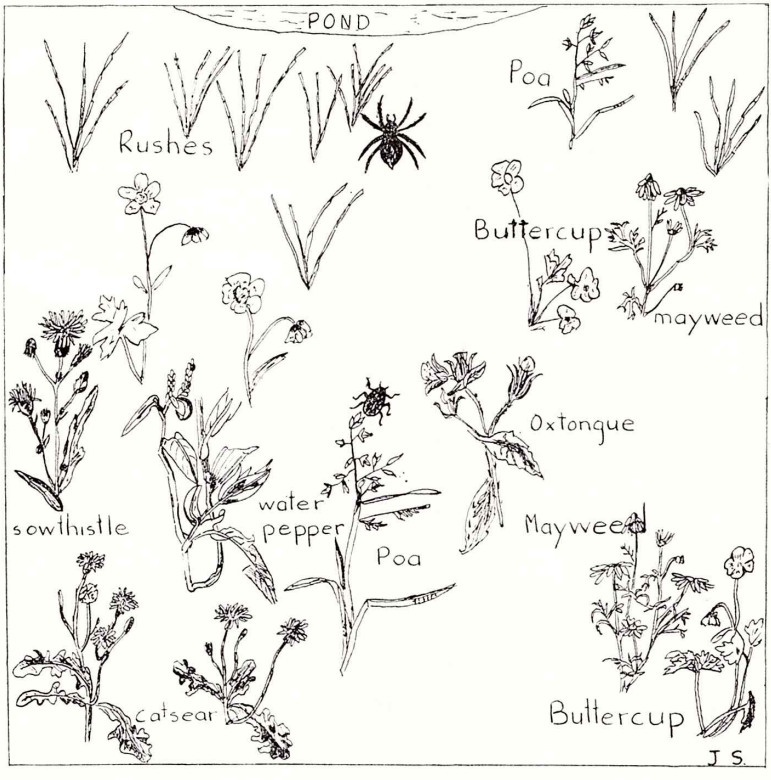
NAMES	FAMILY	IDENTIFICATION	BREATHING	LOCOMOTION	FEEDING	LIFE HISTORY	WHERE TO FIND
Damsel Fly a) Nymph		Slender, 6-legged. Brown or greenish colour. 3 leaf-like tail plates at end of body. Vary in size, some less than ½), others over an inch.	Three leaf-like tail appendages are used to absorb oxygen from the water but other means of breathing must exist because nymphs with no tail gills (due to misadventure) still live. Thought to breathe also through special structures inside the rectum as the dragon-fly nymphs do.	Moves quietly among the water weeds. Can swim with speed for short distances by vigorous strokes of the hind portion of the body.	Carnivorous. Has a "mask" which is kept folded under head. When it has stalked its prey it extends the mask with lightning speed. Strong pinchers at the grasp the prey and the mask is drawn back and prey eaten at leisure.		Among pond weeds with pond net. Many can be caught in spring and early summer. Sweep among water plants and over the bottom.
Damsel Fly b) Adult	Insect: belongs with the dragon-fly, toan order called Odonata.	Wrongly called dragon fly and horse stinger (has no connection with horses and can't sting). There are 2 species both having long slender bodies and being much smaller than the dragonfly. 1. The Red Damselfly: male is bright red; the female duller (markings dull black on back and lighter beneath). 2. The Blue Damselfly: larger than the red species; male has brilliant blue markings, female duller. In both species male differs by having a pair of small claspers or claws at the tip of his tail. The females have swollen tail (egg laying organs.)	Breathes through spiracles (minute holes) along the abdomen. Abdomen can be seen pulsating if watched closely.	When compared with the dragonfly is rather sluggish in flight. 4 narrow and trans-parent wings. Uncoloured except for a small dark spot present in the front of each wing in both sexes.	It catches small insects in flight. Chewing mouth parts (eyes large and bulging used to sight and chase prey.)	Seen flying in tandem fashion. The male clasping the female behind the head with a pair of claspers protruding from his tail. The female lays many eggs while she is attached to the male. Eggs are inserted into plant stems above and below the water level. Depending on water temperature and other factors (food, etc.) eggs take from 3 weeks to several months to hatch. Larvae go through 10-14 moults spending 6 months to 2 years in the water before they crawl into the air, and adult emerges.	Red damsel appears early in warmer weather; blue later. Both in large numbers around all ponds and slow-moving streams. Catch in insect net. with fingers by the wings as they rest on plants.

NAMES	FAMILY	IDENTIFICATION	BREATHING	LOCOMOTION	FEEDING	LIFE HISTORY	WHERE TO FIND
Water Beetle a) Larvae		Yellow-brown, slender, elongated with pointed tail, 6 legs and a head that is flat and bears 6 simple eyes on each side and a pair of fierce-looking nippers. There are 2 small feathered appendages at the posterior end.	The hairy appendages float on the surface when the larvae rises for air, helping to buoy up the body so the air can enter the 2 spiracles at the tip of the tail.	Moves actively about the weeds using legs. When it rises for air it can return quickly to the bottom with much wriggling of the tail. It is lighter than water and floats to the surface if not anchored by legs to the bottom.	Called "water tiger" because of fierce habits. They kill and suck the blood of many soft-backed pond animals, even large tadpoles. The sickle-shaped jaws are hollow with an opening at the tip of each and also an opening at the base of each. The victim is grasped between the jaws and the body juices sucked out and down the tube. It then passes out of the tube through the opening at the base and into the slit-like mouth.		Found among water weeds where most of the animals that make up its food live. Use pond net and sweep.
Water Beetle b) Adult	Insect: Beetles. All insects in this family have their fore wings hardened to form a protective covering for the hind wings which are used for flying.	In N.Z. there are 2 main groups: (i the large water beetle ii) several smaller species. Cannot be mistaken for any other pond animal. Typical, hard, shiny, dark coats. Male is identified by the presence of a round pad on the second to last joint on the front legs.	Effected by the spiracles of the abdomen. Air is taken in between the wing covers and the body. A supply can last the insect 20 or 30 minutes Beetle is lighter than water and floats to the surface. This is probably an adaptation to ensure breathing.	A very efficient paddle for swimming is formed by the flattening of the last segments of the hind-most pair of legs, and a strong brush of hairs lining these segments. Body is flattened from top to bottom to enable ease of movement through water. On very hot days they can fly with great rapidity and a loud humming noise.	Carniverous. Mouth parts designed for biting and there are very well developed jaws.	Female lays egg in the spring by inserting them in a slit she has made in the stem of some water plant. The larvae (or "grubs" as most beetle larvae are called) hatch in about 3 weeks and are full grown in another 4-5 weeks. This is an unusually rapid development. When the larva is fully grown it crawls out of the water and makes a small cell in the earth near the pond. Inside the cell it sheds its skin and the pupa or resting stage is formed. This lasts for only 1-2 weeks if early in summer but if late, will remain until the following spring.	Presence detected as it hurries to the top for air in the open reaches of the pond. Catch in pond net. Make interesting aquarium animals.

NAMES	FAMILY	IDENTIFICATION	BREATHING	LOCOMOTION	FEEDING	LIFE HISTORY	WHERE TO FIND
Bully	Fish	Common about 2″ long but large species found at the mouths of rivers reach over 6″. Mottled. 2 fins on dorsal or upper side. The tail fin is rounded in outline. There is a large fin behind each gill slit and 2 smaller fins on the ventral side (underside) beneath the gills. The last fin is situated on the ventral side towards the tail.	Takes water in through the mouth. The water passes over the gills which can take out the dissolved oxygen. The used water passes out through the gill slit.	Uses tail and shoulder fins for forward thrust. Other fins are used to give stability and steer. The bully has a peculiar habit of standing and even walking on the small fins below the gills.	Many pond animals from snails to even its own young if it is hungry.	Eggs are laid under stones and on submerged branches. Spawning starts about mid-November and continues throughout the summer. Eggs are laid in a large orange mass.	In all ponds where there is a fresh water inlet.
Water Flea or Daphnia	Crustacean. A small member of the same family as crabs, freshwater crayfish and shrimps.	Length about 1½). Just visible as individuals to the naked eye. Body transparent, oval and pale orange in colour. Uses antennae for swimming.		Swims up and down with a curious jerky movement; antennae thrashed up and down.	Algae and bacteria as food. Has jaw for masticating food.	Female carries young in a brood pouch.	Swims in open water early morning and evening. During hotter parts of the day rests on mud at bottom of pond. Can be caught in large numbers in insect net during summer. Good food for larger carnivorous animals.
Water Mite	Mites: Belongs to same family as spiders. (Arachnidae) Mites have only one part to their body; spiders have 2.	Body 1/10″ long almost round in outline. Red or brown or intermediate in colour. Sometimes brilliant; sometimes dark.	Breathe air but can stay under the water for long periods.	Creep about mud and submerged plants. Dart through the water in a particular sort of running glide.	Carniverous and, like spiders, catch their prey and suck the body juices.	Eggs laid on plants, stones or animals. Larvae have only 3 pairs of legs. Attaches itself to some aquatic animal and feeds on blood of host for several months during which time it moults gradually becoming adult.	Can be found attached to back-swimmers. Seems to be common in spring and summer months. Catch with pond net. Usually caught while hunting for other pond inhabitants.

ANIMALS WHICH WERE FOUND AROUND THE POND

NAMES	HABITAT	NICHE
Crickets	Grassed areas around the pond.	Herbivores. Eat the stems of the grasses.
Wasps.	Fly around the margin. Occasionally alighting to drink. Collecting nectar.	Omnivorous.
Slaters.	Moist cool dark places.	Herbivorous. Mostly decayed vegetation.
Dragonfly.	Adults flying over the pond. Also seen around the edges.	Carnivorous. Catch small insects on the wing.



A Sample Square

PART 3 — Inter-Relationships

"Homes"

Have you ever considered that a plant or animal has a home —not necessarily a brick or wooden edifice with a north facing aspect but, nevertheless, a place that belongs to it and is peculiar to it. This perhaps is not difficult to imagine with animals: hedgehogs have their nests, opossums their favourite trees. However in ecology "Home" has a wider significance. It is not just a geographical position but also an association of natural forces at work on it.

To us a home means a house in a certain street in a certain suburb or town; it also means the people that live there with us, the neighbours over the fence, the trees that are planted in the back orchard, the fowls, the lawns that have to be cut. The home is also related to your occupation. It needs to be in such a position that you can get to work each day, or if you work at home to have facilities for this. The lady of the house likes her home to be near shops and transport.

When we think of an animal or plant home we should think of it similarly in terms of three things:

(1) Its **range**—where the species occurs, distribution.

(2) Its **habitat**—The plant or animal's particular "address".

(3) Its **ecological niche**—Its "profession".

e.g. Takahe—Range: Murchison or Keppler Mountains of Fiordland.
Habitat: Tussock Grassland.
Niche: Herbivore (feeds on the base of tall snowshoe tussock stems).

Thus the range would be wherever it was found. This could be, with plants, "Sub tropical zones" or "only on the West Coast of N.Z.". Habitats can vary seasonally, e.g., an animal that spends the summer out in the open but in the winter retreats to the forest for warmth. In a classroom situation it would be quite possible to subdivide the habitat even further, e.g., the oak leaf miner: Major—Forest, Minor—Oak Trees, Micro—Between the skin layers of the leaf.

To place the animal in a niche requires good observation. The niche as such will have more meaning when later in this article we examine food chains and cycles in which all these animals and plants play a most important part.

"Why" Consider these aspects with a class?

Why are these aspects of range habitat and niche worth looking at in our class situation?

If a child is even going to begin to realise that there is such a thing as interdependence and inter-relationship then he must be able first of all to know something about where the organism lives and how it behaves. If he finds that a white butterfly cater-

pillar lives on cabbages and eats the leaves and then through observation learns that the caterpillar is parasitised by the ichneumon wasp grub hatching from an egg laid inside the caterpillar by the adult wasp, he is noticing relationships which in this case are very beneficial to mankind. Otherwise the ichneumon wasp is just a nuisance to be killed and perhaps the green caterpillar a pretty thing to play with and have as a pet.

These understandings assist us in our search for plants and animals. When we know that an animal is a herbivore (niche), that it likes apples (habitat, apple tree) and that it is only found in North Auckland (range) we will know where to look for it.

The Idea of a Community

Anyone who is able to see the difference between a piece of bush and a rocky sea shore line, between a pine forest and a swamp, has begun to understand the term "biotic community"—a community of living things.

Some typical communities are a sandy beach, a pond community, stream community, tussock grassland community, bush community, scrubland community, and pasture community. In one respect they are all alike—there is an indispensable interdependence between the members of the community.

A pond is not just a collection of water plants, pond insects and fish which live together just because they require the same physical conditions, or because they can tolerate one another's presence. The importance of the living (biotic) community is that the plants and animals which compose it are altogether dependent upon one another—they live there because none could live without the others.

In a living community there are no "goodies" or "baddies" —the predators are as essential to the community as are the primary producers of food, the plants. Therefore our definition of a community would be "an interdependent group of animals and plants living in a particular habitat or in a restricted area".

In our own lives, we use the word community to apply to a relatively small group of people such as "a fishing community", or "a saw milling community". Similarly, we may call a huge area of swamp a community, but we may also use the term to apply to a micro-community such as a piece of water-weed with the small animals that live upon it.

Everyone has a job

It is most interesting to notice that every community has its own definite structure, but that the general outline is the same for all communities . . . even for human communities. We recognise standard jobs . . . butcher, grocer, chemist, doctor, dentist, waterside worker, fisherman, banker, truck driver, milkman, teacher, student, preacher, fireman and manufacturer. We know the general outline of the work of each in the community. Each fits into, and

is an essential part of the community as a whole, having his "niche" in the structure of the society in which he lives.

In plant and animal communities too, each individual has its standard job . . . called a "niche", and each "niche" is filled with a different individual. Let's have a look at a few of the common and more important niches in a plant-animal community.

These are the Jobs—

1. **The food manufacturers** are the first essentials in any community. Food has to come from somewhere, and in the case of natural communities, it is the **Plants** which manufacture food by absorbing the sun's energy (see page 7), together with water, and carbon dioxide and minerals, to make carbohydrates, proteins, fats, etc. Plants are the only organisms which can use energy **directly** from the sun . . . and if we think about it, we will realise that all animal life is basically dependent upon plants for its food supply.

2. **The plant eaters** occupy second place. They range in size from elephants to aphids or even zoo-plankton. They might have a taste for only one plant, (e.g. red admiral caterpillars for nettle) or be generalised in their tastes as are rabbits, and opossums. Their standard job is to convert the plants into animal flesh. The most abundant plant-eaters (or herbivores) have been called the "key industry" animals, which support all the flesh-eating animals in the community. It takes many "key industry" animals to keep one carnivore in food.

   The First Level Carnivores—These feed upon the key-industry animals, e.g., ladybirds feed on aphids; preying mantids on flies; thrushes upon worms; cockabullies on pond insects. Usually, these are larger, stronger, and **less** numerous than their prey, and generally they move about singly.

   Second Level Carnivores—These feed upon the first level carnivores, and again, they are larger, fiercer, and **less** numerous than their prey.

   Now the picture is becoming clearer . . .

   Producers eaten by **Herbivores** eaten by **1st Level Carnivores** eaten by **2nd Level Carnivores.**

   We now being to think in terms of a chain, the predators and prey forming links. An example of a secondary carnivore is an eel, which has fed on bullies or frogs, which have fed on insects, which have fed on plants—the primary producers of food.

Some Hangers-on

An impolite term sometimes applied to a person, is "parasite" —and we know just what it implies. So in nature we find parasites, organisms which derive their energy by exploiting other living organisms without killing them. Almost every living thing may

be parasited. The parasite animals or plants are utterly dependent upon their "hosts" for survival, and if separate from the host, will most certainly die. Scavengers are also known in human society! But these are not similar to those found in our natural environment, where they may be defined as **animals which eat dead plants and animals.** Earthworms are most useful scavengers in soil; ants perform herculean clearing-up tasks on the surface of the soil. On the seashore, we find that the hermit crabs and black-backed gulls fill this niche.

Even smaller organisms fill the lowliest niches, and these are utterly essential to us in ensuring continuity of life on this earth. They are the decomposers, mainly bacteria and fungi, which decompose dead plant and animal material into simpler substances. These substances can then be converted into nitrogen compounds which plants may use for building up proteins, etc. The decomposers also release from dead matter the carbon dioxide which may be re-used in the photosynthesis of plants.

Some niches are general or basic ones such as are occupied by earthworms, the green plant, or the "key-industry" animals, which occur in every major community, and are indispensable. Other niches are highly specialised, e.g. those of starlings and mynas which sit on the backs of sheep and eat the external parasites in the form of ticks.

No large niche is monopolised by any one kind of animal. The frog which specialises in catching insects flying over a pond, must compete with the dragonfly which, however, may feed at dusk, while the frog feeds mainly during daylight hours.

We have now discovered that ALL living things are interdependent. No plant, much less any animal, can exist apart from the other organisms and elements which combine to form its environment.

Successions

A word must be said concerning the ultimate "destiny" of a pond. You will know of examples of ponds which gradually over a period of a few years have "dried up" and were obliterated by plant growth.

A community is never really stable, and a pond community is perhaps a clear example of this. Steps that occur in the formation, life and "death" of a pond are as follows:

1. A permanent depression is formed either naturally by wind, earthquake etc. or artificially (by man).
2. The depression fills with water.
3. The first of the plant colonisers are the algae, the smallest plants.

   These provide suitable conditions for:—
4. Larger submerged plants to grow—Anacharis, potomogeton etc.

5. Debris finds its way into the pond and dead plant material raises the level of the pond "bottom" making the pond shallower. Also during this stage the pond contains animals which are sustained by the plant material, the plants providing both food and oxygen.
6. Moisture-loving plants around the margin grow out and into the now shallower water, debris collects around them, raising the pond floor even further.
7. Taking the place of the reeds at the edge of the pond are the sedges and other plants which intermingle with them. These trap water-borne, and wind-carried soil, and accumulated plant debris, and transpire enormous quantities of water. The soil therefore becomes too dry for them and these plants give way to:—
8. Grassland.

This creeping death for the pond continues in and around it until the spot which once was filled with water now supports a grassland community. This is a very clear-cut case of plant succession. Many side tracks may develop, or the establishment of a climax grassland community may he hastened by artificial draining.

Any pond, therefore is not divorced from its surroundings, but is inter-related with them. This is the reason for including our "picture squares" (quadrats) and population lines (transects) in this study. They present a picture which extends from the water up the pond back to the surrounding vegetation.

NEEDS AND HOW THEY ARE SUPPLIED

A. Energy Needs

From the lists of animals and plants presented, it can be seen that there is a lot of activity taking place at the pond. The energy for this activity (i.e. growth and movement) is obtained from sunlight. Energy fixation occurs when plants, by the process of photosynthesis, "fix" or trap light energy and make it available in the form of sugars and starch. We can see plants all around the pond—and **in** the pond—engaged in this work of energy production or food-building. Scientists have caried out experiments to estimate the amount of energy coming from the sun that is actually used or stored in the plant. Of the 4,700 million calories per hectare that reach the earth, only 58 million cal./ha. are absorbed by plants. This is just over 1%—not very efficiently by modern standards! But this 1% forms a great energy pool which all animals and we as human beings ultimately rely on. As it is handed down from plant to animal and from prey to predator it is gradually dissipated and lost, so that we speak of **energy levels.** Energy from the plant is first consumed by a herbivore, this in turn by a carnivore, and in the end by decomposers—bacteria and fungi. The energy then is expended and has reached the end of its usefulness. All the activity of the herbivores, carnivores, and

decomposers is carried out with only small percentages of the original 1% of the sun's radiated energy that reached the plant. This is available to them after the level above has carried out all its respiratory activities, and used a large proportion of the energy available to it. Thus, as we go from one level to the next the available energy decreases step by step.

Algae (sometimes called pond slime) are one—celled plants which form the basic food of a great many of the herbivores and thus play the biggest part in bringing energy into the community. There are other tiny microscopic plants such as desmids and diatoms. These too form the food of such animals as snails, water boatmen, hydra, daphnia, bryozoans and caddis fly larvae.

Energy is further transferred when these animals in turn are preyed upon by larger ones. Bullies, water beetles and frogs are just a few of the carnivores which rely upon herbivores for their food. The adult stages of caddis flies are preyed upon by adult dragon flies and damsel flies when they emerge from the water. If the mud and debris at the bottom of this pond had been examined we would have found bacteria which rely on dead animals and other organic debris for their food. This transfer of food from plants to tertiary carnivores can be shown pictorially as a pyramid —the broad case indicating that there are many more producers than consumers, and that the amount of available food energy decreases as one form feeds on another.

As the predator gets bigger so the quantity of food needed to satisfy its requirements increases.

Food Chains

We have shown how energy is transferred to the predator by the eating of its prey. We shall now consider which plants and animals fit into the different trophic (feeding) levels of the food chain.

Producers:

(a) In the water—Pond weeds (higher plants), Algae, Diatoms and Desmids.

(b) On the "dry bank"—Grassland weeds.

Herbivores:

(a) In the water—Snails, Caddis larvae, Water Boatmen.

(b) On the bank—Crickets, Slaters.

Carnivores:

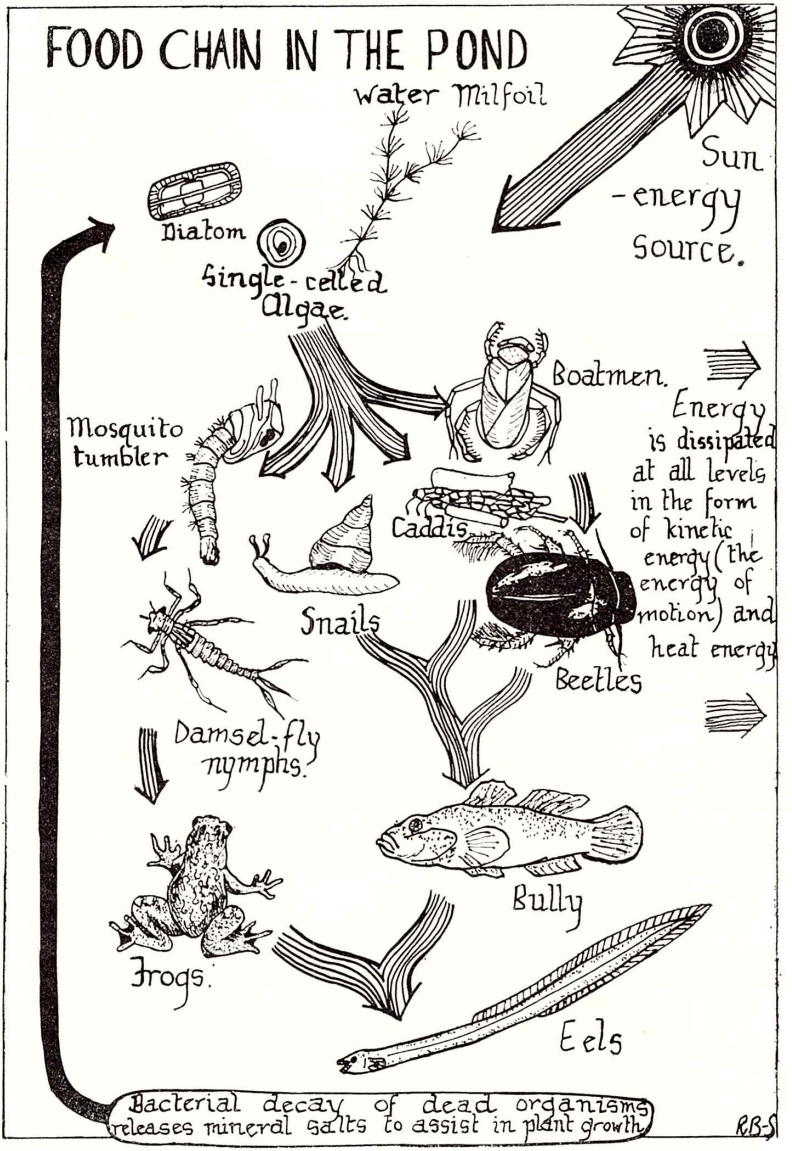
1st level (Feed on herbivores)—Back swimmers, Dragonfly nymphs, Bullies, Water beetles, Bryozoans, Hydra.

2nd level—Dragon flies, Damsel flies, Bullies, Frogs, Eels.

Omnivores: Muscovy Ducks.

A pond-food chain is shown on p. 40.

The most important part in this chain is played by the first level of producers (plants). It is upon these that the other animals and decomposers depend for their energy supply.


FOOD CHAIN IN THE POND
Water Milfoil
Sun
- energy
source.
Diatom
Single-celled
Algae.
Boatmen.
Mosquito
tumbler
Energy
is dissipated
at all levels
in the form
of kinetic
energy (the
energy of
motion) and
heat energy
Caddis
Snails
Beetles
Damsel-fly
nymphs.
Bully
Frogs.
Eels
Bacterial decay of dead organisms
releases mineral salts to assist in plant growth
RB-S

Food Webs

By making a diagram of "what eats what" and "what is eaten by what" we can construct a Food Web, similar to the food-chain above but showing cross-relations between the animals. The bully, for example, might be found preying not only on caddises (where it is a 1st level consumer) but also on damsel fly nymphs (being now a 2nd level consumer).

B. Material Needs

We have seen that energy is constantly fed into our plant-animal community from the sun, and as constantly used and lost. In contrast to this energy which is continually being replaced, plants and animals need materials for growth and these are not replaced from outside sources. They have to be used in one form and then returned in another so that they can be used over and over again.

The Carbon Cycle

The most important of these materials are carbon dioxide and water, the raw materials of food-building. Both are low energy materials. Using the energy of sunlight, plants convert them into high energy carbon compounds (e.g. starch, sugar, oils) which are available to both plant and animal cells as food. As they are broken down (e.g. in digestion by animals) they give up their energy for the animal's use and are returned to the air in their original form, that of carbon dioxide and water. The energy-building process we call photosynthesis, the energy-using process we call respiration. Thus carbon dioxide and water move in great cycles, receiving energy and giving it out again. A simple form of the carbon cycle is given in the illustration on page 43.

The seasons play a very large part in the life of the community. The best way to observe seasonal change is to visit the pond several times during the year, paying attention to the following:

(a) Water temperature taken at regular intervals. (If possible take the temperature at different levels.)

(b) Height of water noted at each visit.

(c) Compare abundance of different species, e.g., frogs, beetles, water boatmen.

(d) Note any new growth on pond weeds (perhaps best done through comparison of photographs taken from the same place on each visit).

(e) Compare amount of activity in and around the pond on a hot summer's day and a cold winter's one.

(f) Note effect of seasons on the plants on the margin of the pond: flowering times, seeding, new seedlings appearing, times of greatest growth, times when plants die off.

The Results

We hope that we have managed to set out some of the factors involved in an ecological study. Most of the facts can be found out by the pupils by **directed observation.** If we are going to interest them in "science" we must show them that it provides a way of solving problems.

Because some classes in working with problems that we have covered in this article are going to come up with further questions, and for the assistance of teachers who wish to extend the topic beyond the scope of this article, we have included at the end a bibliography. Here we have set out books which give a far deeper and wider picture of ecology and pond studies than we are able to. Books such as those by Buchshaum and Odum will be well worth acquiring.

Do not attempt to do a study such as this in one week. It is a year's work, if it is treated on an ecological basis. Intersperse it with other work by all means but try to give the children the opportunity of seeing the whole picture, not just a part.

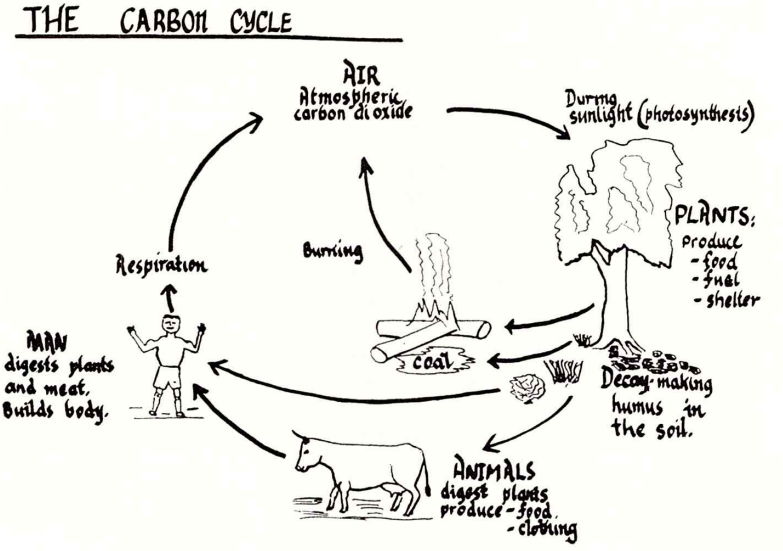
To be of general value the study should motivate many areas of work in the classroom, e.g., art, reading, writing, listening and talking.

A Warning

Do not attempt a study such as this unless you are well prepared and enthusiastic. Order films in plenty of time, also country library service books. Find books in the school library. Know where the study leads. If it is planned well, it should prove to be interesting and informative and should serve to extend the children in a very worthwhile fashion. Unless both teacher and class are keen, and the children themselves possess ability somewhat beyond average, the simple pond study which was the subject of our first article will prove to be more appropriate than the more advanced ecological treatment which we have described here.

To Sum Up

Thus we find that the pond community is a complex of interrelationships. If we forget the essential intake of energy from the sun it is very much self-contained. It relies upon the reproduction of its members for the continuation of life. If one member dies, it is possible that the whole structure of the pond life will be altered. If for some reason, perhaps disease, the plant life in the pond were to die out, then the following animals, which are herbivores, would also die—potamopyrgus snails, stick caddis, water boatmen, sandy cased caddis. As a result, bullies would die out, and dytiscid beetles, back-swimmers, and the muscovy ducks would move elsewhere. The whole life structure of the pond is based upon the primary producers, the plants.



LIST OF FILMS AND FILMSTRIPS

Films:

"THE WEB OF LIFE"—Introducing the idea of "balance" in nature. (United States Information Service.)

"THE INTERDEPENDENCE OF POND LIFE"—An excellent film on the relationships between plants and animals in a pond. (Gaumont British Instructional.)

"SPRING COMES TO A POND"—National Film Library.

"LIFE OF FRESH WATER POLYP . . . HYDRA"—National Film Library.

"THE NITROGEN CYCLE"—National Film Library.

Filmstrips:

"Hydra" 91/55, "Pond Life" 0/251, "Pond and Stream Life" 55/135, "Keeping an Aquarium" 61/111.

List of books that will be of particular help to the teacher:

"Fundamentals of Ecology", Sanders (Odum).

"Basic Ecology", Buchshaum (Bockwood Press).

"Introduction to Plant Ecology", Tansley (George Allen and Unwin Press).

"Field Studies in Ecology", R. Bracher (Arrowsmith).

THE FRESHWATER STREAM

Brian T. O'Rourke

By and large the generalities in the article concerned with ecology and the pond, apply equally to the stream. In the stream the energy chain begins with the "fixing" of the energy of sunlight by algae, diatoms and higher plants. This energy is utilised in turn by successive layers of consumer organisms as in the pond. The adaptations of plants and animals living in streams and ponds may be strongly contrasted, however, because of the presence of a current in the former, and its absence in the latter. There is, in fact, a gradation from slow moving streams which may harbour pond dwelling organisms to fast, unstable shingle or boulder streams which may contain only organisms peculiarly adapted to that habitat. One stream in its passage from mountain to sea may exhibit a complete range of habitat types; some streams may range from shingle torrent to muddy backwater within a few yards. The opportunity for contrast which most streams afford is well worth making use of.

Conditions and Adaptations

As the range of conditions in a given stream may vary greatly, the following comments will apply to an "average" shingle stream which has frequent ripples, large flat pools, and occasional quieter and deeper "holes".

The stream is characterised by the presence of a current. The flow of water is turbulent in places, often broken and thus well oxygenated. The plant life, except in sheltered backwaters and oxbows, is firmly fixed. Brown diatoms cover the bed and some green filamentous algae may be present. In more stable parts of the stream, Canadian pond weed (Anacharis canadensis), water milfoil (Myriophyllum spp.) and water crowfoot (Ranunculus fluitans) may be found firmly rooted in the substrate.

In open areas all animals with the exception of larger and stronger fish, live either underneath, close beside, or fastened to, the top of stones. Small molluscs (e.g., Potamopyrgus spp.—a freshwater snail) maintain their hold on stones by clinging with a muscular foot. Flattening of body form to allow close adherence to stones and easy passage through narrow openings, is a common adaptation. This is plainly exhibited by the most abundant of the mayfly nymphs (Deleatidium spp.) and the predatory stonefly (Stenoperla). Caddis fly larvae of various species cling firmly to the sides of stones with strong legs and in some cases build webs with which to trap passing organisms. Thickly-built bullies lurk between stones in relatively sheltered water. Only spindle-shaped trout, salmon and whitebait swim freely in open water.

Checklist of Common Stream Animals

The references referred to are as follows:

D: *Field Notes for the Freshwater Naturalist* — Dickinson
B: *Handbook of Nature Study* — Beggs
P: *Native Animals of New Zealand* — Powell

	D	P	B
Mayfly Nymphs	15	44	194
Stonefly Nymphs	22	48	
Caddis Fly Larvae (horny-cased caddis sandy-cased caddis spiral caddis stick caddis pebble-house caddis Oxyathera)	19	52	196
Dobson Fly Larvae (creeper or toe-biter)	22		195
Fly Larvae (midges, sandflies)	26	51	189
Freshwater Crayfish and other crustaceans	27-30	37	
Freshwater Snails	32	33-34	
Bivalve Molluscs (mussel, Corneocyclus)	29	33	
Brown Trout	12		196
Rainbow Trout	13		196
Bully	7		196
Eel	3	64	196
Whitebait (Inanga)	5		
Smelt	9		
Kokopu	5	63	

Descriptions of the animals may be found readily in the suggested references, and in the following tables:

A Food Chain in the Stream

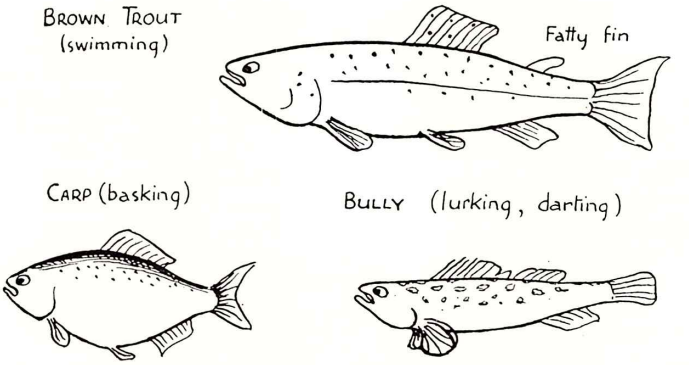
Freshwater snails, mayfly nymphs, and some caddis fly larvae are the dominant herbivores or first level consumers. In other respects the food chain of the stream closely resembles that already pictured in the article dealing with the pond.

The Fish

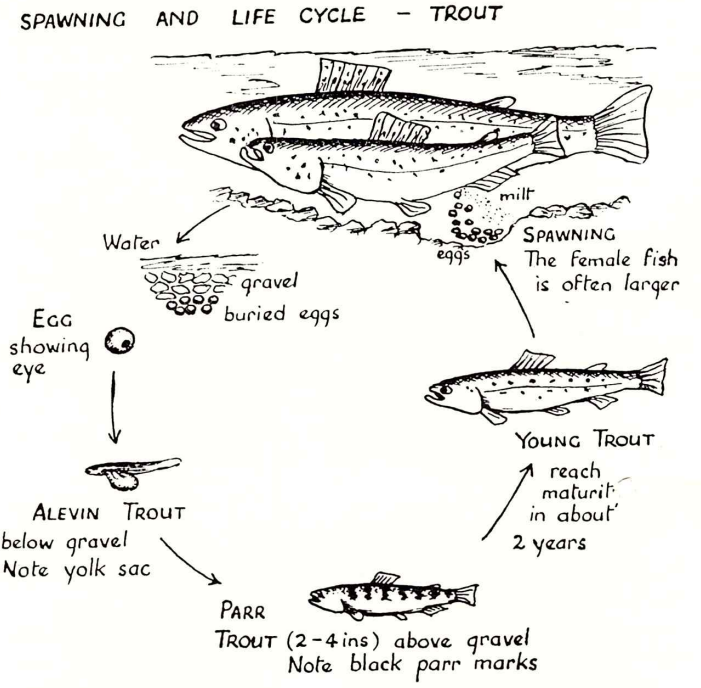
Freshwater fish can be divided into two groups:

1. Native fishes (including the eels, lampreys, bullies, inanga, smelt and *native* "trout").
2. Introduced fishes (brown and rainbow trout, sockeye, quinnat and Atlantic salmon, char, carp, perch and tench).

Full details of the lives of these fishes can be obtained from the readily available sources referred to in the bibliography. In this section, examples of fish and methods have been selected with the hope that they may provide a lead to the teacher.



Note the extreme differences in shape



Whitebait or Inanga

An adult whitebait (a fish about four inches long, often called minnow or inaccurately, smelt, and found in ditches and ponds connected to rivers) may easily be kept in an aquarium. In early spring several immature whitebait (the stage we relish so much as a food) may also be placed in the tank. Group the children around the aquarium and tell the story of the fish.

A Fish Traveller

Those of the whitebait, running up the rivers in early spring, which escape nets, trout, gulls and other predators find their way into ponds and ditches where they grow to a length of at least four inches. Examine the fish yourself and discover the differences between young and adult stages. Point these out to the children (transparency and colour).

The adult whitebait in the following autumn migrate down the stream and remain in estuarine waters until a spring tide sweeps water on to land which is usually dry. The adult whitebait move in with the tide and deposit their eggs on the stems of clover and other plants which are found in such places. After two weeks or a month (depending on the tides) the eggs hatch and the young fish with tiny yolk sacs attached to their bodies drift out to sea. The yolk sac is soon absorbed and the little fish feed on the abundant life of the sea until they begin their ascent of the rivers as whitebait.

The story, if dramatically told, may be the basis of informal discussions or story writing. Interest aroused in this manner should lead on to investigations into the feeding, swimming, breathing and sensing habits of fish. For upper classes the relationship between man and the whitebait could be stressed, i.e. how the catches of whitebait deplete the breeding stock, how introduced trout have taken their toll, how the draining of ponds and swampy lands has reduced the area in which adult whitebait may find a living, and how the reclamation of estuarine marshlands and the grazing of stock may reduce the regions in which whitebait are able to lay their eggs.

Native "trout" somewhat resemble adult whitebait but are rather more heavily built. Native "trout" are not to be confused with the introduced brown and rainbow trout to which they are not closely related. Kokupu, the Maori name, is better than "native trout".

A Fish Stranger

The popular fighting trout and salmon of our rivers and streams are not natives of this country. The early settlers found streams filled with eels and inanga but there were no game fish. Several attempts were made to bring trout from England and success was finally achieved by transporting eggs from Tasmania in 1867.

Trout prospered in New Zealand streams and grew to sizes far exceeding that usually attained in their native lands. It is possible to tap the child's interest in angling with a view to developing a wider appreciation of the world of underwater.

From May to July, brown trout begin their upstream migration to the spawning grounds. For some trout this may mean a long journey from estuarine parts of the stream up to where shallow cold water runs swiftly over clean stones. For other trout the journey may be only a few yards. Rainbow trout do not carry out this migration until much later and spawn after the brown trout. Migration may easily be observed by children.

On the shallow, swift, gravelly reaches of the stream which are the spawning grounds, the female (hen) trout selects a patch and begins to dig a "redd". This is achieved by scooping aside the gravel with flank and tail until a depression somewhat wider than her body and up to six inches deep has been excavated. The successful male of the half dozen would-be suitors who have been jockeying for position behind the hen move up so that his vent (the opening on the belly just in front of the anal fin) is slightly in advance of hers. The two fish lie side by side. Then the female with a slight arching of the back, exudes a stream of yellow-orange eggs. These are carried to the bottom in the eddy current of the redd. At the same moment the male ejects a stream of fine white milt into the water. This is carried over the eggs by the eddy current and fertilisation takes place. The process is repeated over a period of seven days until all the trout's eggs have been deposited. After each batch of eggs is set down the female fish digs on upstream, the disturbed gravel serving to cover the recently laid eggs.

The Facts of Reproduction

Spawning places in streams will be situated within easy walking distance of many schools. If the ground has been thoroughly examined by the teacher, a class can be guided to a spot on the riverbank from which spawning can be observed. The primary rules of approach are: tread lightly and move slowly.

The spawning of trout will present a clear picture of reproduction to the child; the rivalry of the males and often severe struggle between males, the building of the redd by the female fish, the laying of eggs, their fertilisation, and subsequent development.

Things to Do

Construct a dated frieze showing upstream movement of the fish, spawning, differences observed between male and female fish (male fish slimmer and darker with hooked lower jaw especially in large specimens, female fish lighter in colour and plump with eggs), worn out fish after spawning, often with patches of mould where scales have been rubbed off in fighting and redd-digging.

The frieze could also depict development of the eggs.

Buried in gravel the eggs develop until after about fifty days the little fish called alevins hatch out. The prominent yellow orange yolk sac is carried around for another three weeks during which time the young trout do not feed but work their way slowly to the surface of the gravel. Nature ensures that only the strongest complete this journey. When the yolk sac has been fully absorbed the trout are now about an inch and a half long and begin to feed on tiny water animals. Growth from this point depends largely on the amount of food present.

The frieze may be completed by showing the development of the eggs and young trout. The hazards of the riverbed could be discussed: eggs may be washed away by floods or squashed between stones, water birds may dig up redds; one dead egg may develop mould which will spread to the rest of the batch; the little fish may not be able to fight their way upwards through the gravel; eels, shags, bullies and older trout may take their toll. Here is an excellent opportunity of illustrating the struggle for existence in which only the fittest and luckiest survive.

Policemen and Courts of Law

Although half a dozen trout eggs may be very easily kept in a dish of clean water (that is, after they have reached the stage where the eye is visible—about ten days after fertilisation) and although the hatching and the growth of the young fish can be observed in this situation there are several points to be borne in mind:

1. It is absolutely illegal to interfere with a redd in any stream.
2. Trout and salmon are the express concern of acclimatization societies and may not be tampered with in any way.
3. Acclimatization societies may, if approached, be willing to supply ova to interested groups of teachers. *It is worth a try.* The interest children have in the eggs and young fish is immense.

A Study

A large part of the year's work in nature study could be based upon the interest which is bound to develop from a study of, for example, the spawning of trout. Working from the trout we find further interest in its food, enemies and surroundings.

Activity would involve field trips, team discovery and the preparation of illustrated group reports to be combined into a book called "The Stream" or "The Lakeside".

Central Theme

Life cycle of selected fish (trout, salmon, perch etc.). Field trips and indoor observation if eggs are available.

Associated Themes

Food animals—Found on and under stones or in weed along the bank. Bullies, prawns (both of these animals will thrive in

aquaria), mayfly larvae (with three tails and under stones) stonefly larvae (two tails) caddis fly larvae (with various types of cases) and tiny water snails. These can best be observed in soup plates.

An armoured animal: Freshwater crayfish (occasionally encountered under banks in slow flowing places). There will be no lack of interest in these animals. Direct attention to the heavy armour which is shed regularly, the walking legs, the pincers, eyes on stalks and perhaps the eggs under the tail of the females.

Predators: Eels and lampreys are animals which reduce numbers of trout. Young eels and lampreys may easily be kept in aquaria and their habits studied. References will give ample information on both eel and lamprey.

Stream Birds: Ducks, pukeko, bitterns, kingfishers, white-faced herons and shags may be encountered near streams. Follow them through the year: plumage changes, nesting and identification would be worthwhile topics. For upper school children: try to assess relationships between fish and birds. What are the methods used by birds in the pursuit of their prey?

Water Plants: These plants grow in the stream: Canadian pond weed, water milfoil, crowfoot, Potomogeton and duckweed. Learn to identify them. Of what importance are they? (Oxygenation, cover for prawns, cover for young fish, hideouts for old fish, hold the riverbed together.) Grow some of these weeds in the aquarium.

Waterloving Plants: These plants grow beside the stream: monkey musk, watercress, batchelor's button, water pimpernel, forget-me-not, floating sweet grass, willows and poplars. Follow these through the year: leaves, flowers; learn to recognise the plants. What relation do they bear to the fish? (Conceal bitterns, kingfishers, harbour insects which drop into the water and form food for fish, hold stream banks together and make the riverbed more permanent, create eddies and backwaters where food animals thrive.)

Method

Techniques as for the pond study apply. However, it should be noted that the statistical treatment of material is not generally suitable for primary school classes. Equipment for the stream trip includes sieves and muslin nets. A net should be placed downstream from a suitable stone and the organisms discovered washed into the net by gently shaking the stone. Remember that stream animals are in general, adapted to the presence of large amounts of dissolved oxygen. They must be kept in flat dishes preferably with clean gravel under which they may hide. The water in the container should be very shallow. If maintained in this way, the creatures will be available for study over a period of several weeks. For detailed method refer to Nature Study Bulletin, Supplement No. 1 p. 16—*Team Discovery—Pond or Stream Life.*

References:

The Pool	A Primary School Bulletin, A. Torrie.
Pond and Stream	Post Primary Bulletin, Vol. 15, No. 1.
Field Notes for the Freshwater Naturalist	P. Dickinson
Native and Introduced Freshwater Fishes	C. S. Woods
Freshwater Fishes of New Zealand	G. Stokell
Native Animals of New Zealand	Powell
Handbook of Nature Study	D. Beggs
Nature Study Bulletins:	
Supplement No. 1 September, 1958	*Method* *Living Underwater*
Supplement No. 2 May, 1957	*Air Science—Water Science* *Fish Studies*

To use this key: Begin at the top with the main divisions. Do not attempt to identify specimens from the illustrations alone.

KEY TO EASILY SEEN POND AND STREAM LIFE

by Fiona Todd

No legs; or has a case

LOOK FIRST FOR JOINTED LEGS

Appears to have one leg—not jointed.

Shells

Spiral tapering shell
Pond Snails

Flattened spiral shell.
Ramshorn Snail.

In moveable case

Case of straw or stick.
Stick Caddis.

Case of horny material.
Horny-cased Caddis.

Smooth Slimy Body

Very flat, glides along, dark on top, 2 eyes.
Flatworm.

Tiny, white with a sucker and 6 tentacles.
Tentacle Flat Worm.

Segmented bodies

With two suckers.
Leech.

Small, head with tiny bristles, tube at tail.
Mosquito Wriggler.

Segmented bodies

Tiny, cemented to rocks or weed. One proleg near head (two fused together); feeding fans. *Sandfly Larva.*

Tiny flat "shell" made of sand grains. *Spiral Caddis.*

Case of cemented sand grains. *Sandy-Cased Caddis.*

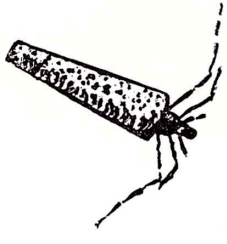
White, long, worm-like. *Round Worm.*

Small comma-shaped tube near tail. *Mosquito tumbler.*

Small, red and rather worm-like. One pro-leg near head. Blood worm or *Midge Larva.* About 1in.

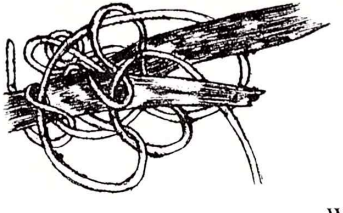
No obvious head, skin leathery; has air bubble. *Soldier Fly.* With lobes at tail *Crane Fly).*

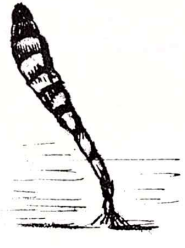
Two shells enclosing animal—Mussels. Large—*Fresh water Mussel.* Small—*Orb or Pea Mussels.*



More rarely, large stick caddis (case of leaves and debris); or tiny caddis in a transparent case.

White, very long and thin; tied in knots. *Gordian or Hair Worm.*





White, fat body, telescopic tail; foul water only. *Rat-tailed Maggot.*

SIX JOINTED LEGS

NO TAILS

Dark, small head.
Parnid Beetle Larva

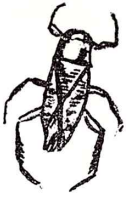
Hard backs.

Water Bugs.

Tiny, usually red.
Young Water Mite.

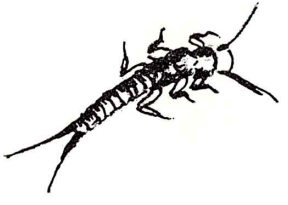
Hard Backs.
Water Beetles.

Tiny running on the surface.
Pond Skater.



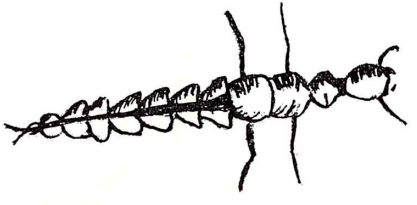
TWO TAILS

Long tails, flattened bodies, large or small.
Stone Fly Nymphs.

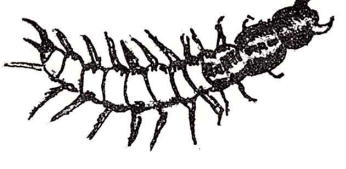


Short tails, with hooks and bristles, may be in stone case
Tufted gills along side.
Stony-cased Caddis.

Tiny tails, 1st pair legs as pincers.
Green Caddis, ¾in.

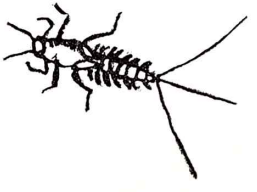


Eight leg-like gills at side; large jaws.
Dobson Fly Larva (toe biter).

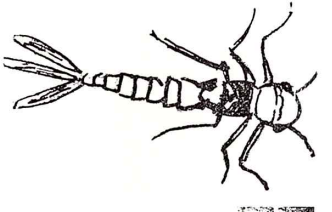


THREE TAILS

Thin tails. Very variable according to species. Numerous.
Mayfly Nymph.

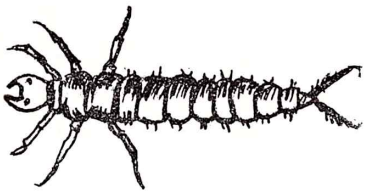


Leaf-like tail gills; among weed.
Damsel-fly Nymph.



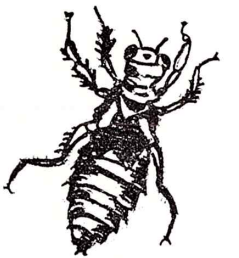
Uses 1 pair legs for swimming.
Backswimmer.
Uses 2 pairs legs for swimming.
Water Boatman.

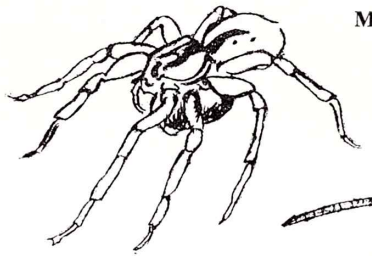
Short tails, with hooks.
Pink Caddis, ¾in.



Very active, slim larva; large jaws; bubble of air.
Water Tiger (and others).
(Diving Beetle Larva).

Squat, ugly, wing buds, small tails.
Dragon-fly Nymph.





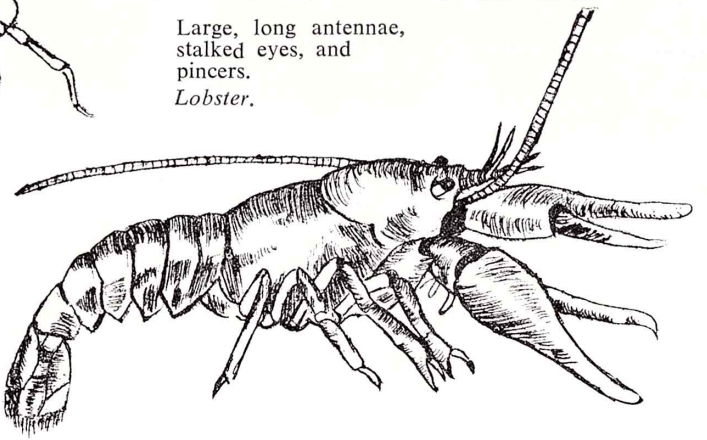
Large, spider. Near stream margin or hiding underneath the surface.
"Water Spider".

EIGHT LEGS

Tiny, usually bright red or black.
Water Mite.

MORE THAN SIX JOINTED LEG TEN LEGS

Large, long antennae, stalked eyes, and pincers.
Lobster.



TINY CREATURES (use a hand lens)

Amphipods.
Fresh-water shrimps, e.g. *Gammarus.*

Copepods.
ea. *Cyclops.*

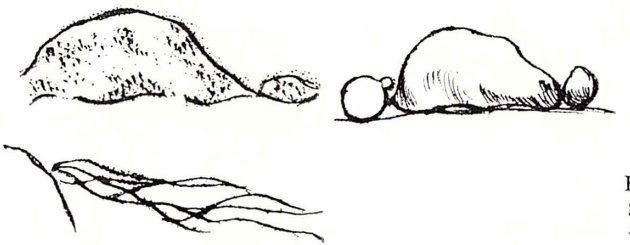
Ostracods.

Cladocera.
e.g. Cyclops.
Daphnia.

Numerous smaller animals and plants particularly in still water, form with those above, the basis of the feeding pyramid.

PLANTS

'Scum', covering on a rock or vegetation, long green filaments.
Algae 'Scum' "Frogs' Eggs"



Floating; red or green, small.
Water Fern.

In damp situations not in water. Tufted spikes.

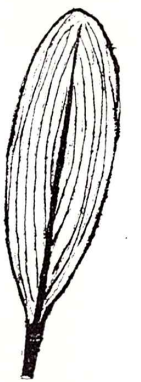
Round stem.

Triangular solid stem.

Sedges; ('Cutty-grass').

Rushes.

Coppery colour. May have long, thin underwater leaves; oval surface ones. Parallel veins in leaves.
Potamageton or *Copper Weed.*



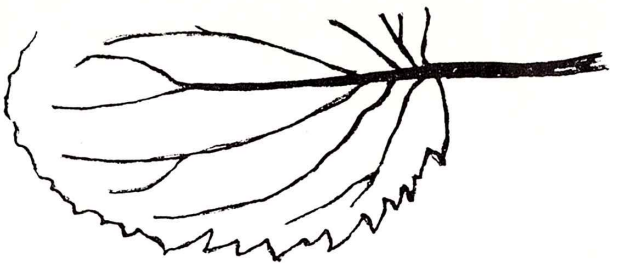
Floating; light green tiny.
Duckweed.

Spirogyra

Large plant; long leaves with veins and air cells. Flowers—"bulrushes". Margin of water.
Raupo.

Long grass leaves, floating from margin. Canoe tip—
Floating Sweet Grass.

Large, light green leaves; yellow flowers. Water margin.
Monkey Musk.



Small leaves, light, bright green. Above water leaves round — typically has top resting on the surface; but may be submerged completely with longer, narrower leaves.

Starwort.

Under-water. Leaves in whorls, each one very finely divided. One type may also have oval surface leaves.

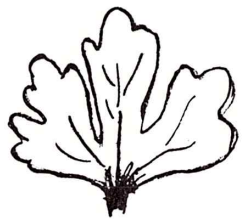
Water Milfoil.

Leaves large but variable in shape— often fiddle-shaped. Water margins,.

Water Cress.

Leaves variable but lobed and divided (usually into 3). In swampy ground.

Buttercup.

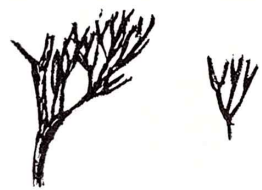


Leaves around stem all the way up. Mid-green. Submerged.

Anacharis or Canadian Pond Weed.

Often in swift current Leaves finely divided but in two's at tips A buttercup.

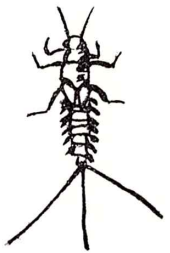
Water Buttercup.



Others may be:
Mint
Forgetmenot

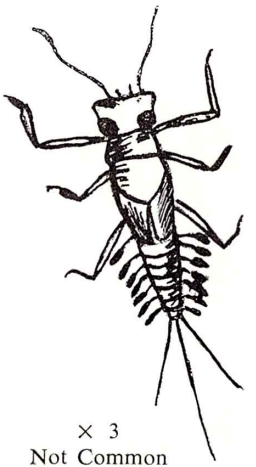
Notes on Stream Life

Ephemeroptera Order (Mayflies)
(living a day: wing).

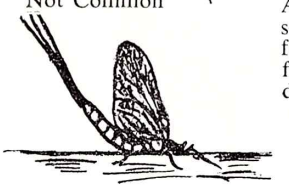


Common mayfly (small).

mayfly. Swimming × 2



× 3
Not Common



LIFE CYCLE

Egg to Nymph
(Laid in water (Feeding
or under rocks). underwater).

moult
Sub-imago to Adult
(Dun) (Spinner-
Mature)

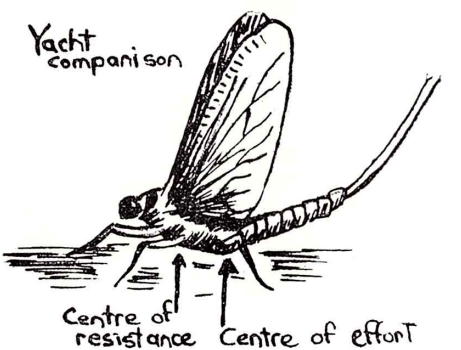
MAYFLY NYMPHS

Varying types in running water. Differ in shape, size, gills and tail length. At least twenty-one species in N.Z. of three major types —crawling (under stones and at edge); swimming, burrowing (in sandy patches). Three tail filaments. Seven pairs of gills along side or back—flat plates, fringed, or forked; usually moved rapidly to assist respiration. Two pairs of wing buds; one obvious.

Food—an elaborate system of rakes and brushes for minute plants (algae, etc.) growing on rocks. Some eat debris swept down by the current. Tend to be very flattened in shape, especially those in swift water.

Very numerous; basic animal in many food chains as eaten by trout and other fish, large stonefly nymphs. Dobson fly larva, etc. Most do not live well in captivity.

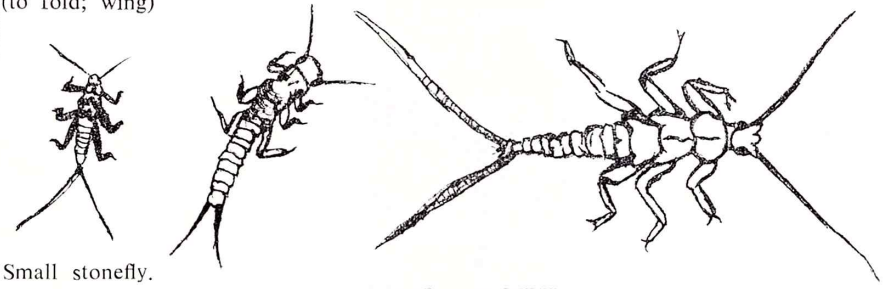
Adults have no mouths so live no more than a few days. Males tend to fly in numbers up and down stream.



Nymph stage may last 9 months or over 1 year.
Dun is duller and stouter than the gauzy-winger spinner; and is the only insect which can fly when immature. When on the water (at emergence) does not tip over (see illustration).

Plecoptera Order—Stoneflies.
(to fold; wing)

Large green stonefly.



Small stonefly.

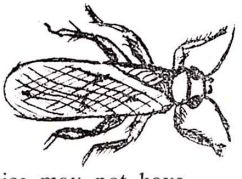
STONEFLY NYMPHS

Many species of varying size and habits. Two tails. Gills may not be visible; may be tufts at end, or at base of legs; or five pairs of thin hair-like ones at the side of the abdomen. Long antennae.

Larger nymphs carnivorous (feed on mayflies, etc.); smaller vegetarian probably feeding on debris. Two pairs of wing buds. Eaten by trout and eels. Do not live well in captivity.

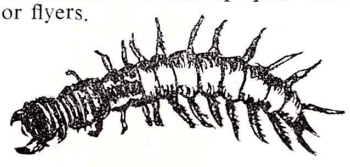
LIFE CYCLE

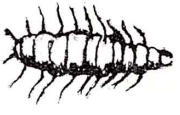
Eggs—laid in water. to Nymph (may last over 1 year). to Adult



Adults may be grass green or slate grey All species may not have two tail processes. Wings are folded over and opaque. Often seen walking over stones near water; poor flyers.

Neuroptera Order
Dobson flies
(nerve wing).



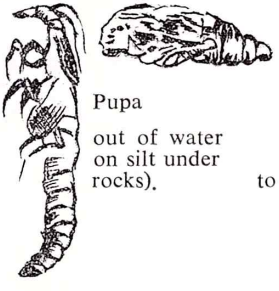


Young larva

DOBSON FLY LARVAE

Called Alder-fly overseas; in New Zealand usually toe-biter or creeper. Grows into a large larva with eight gills. Two hooks at the end of the body cling to stones, in swift water. Found at certain times of the year (pupating in winter) on gravel underneath stones. Large jaws—carnivorous (feeds on mayflies etc.). Curls up when touched. Eaten by trout and eels.

LIFE CYCLE

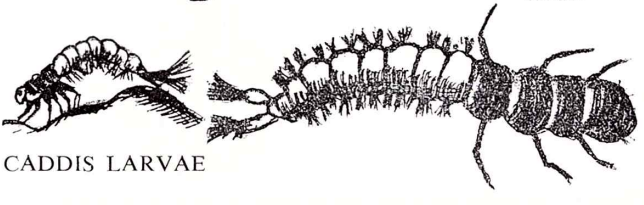


Eggs (On veg., above water) to Larva to Pupa out of water on silt under rocks). to

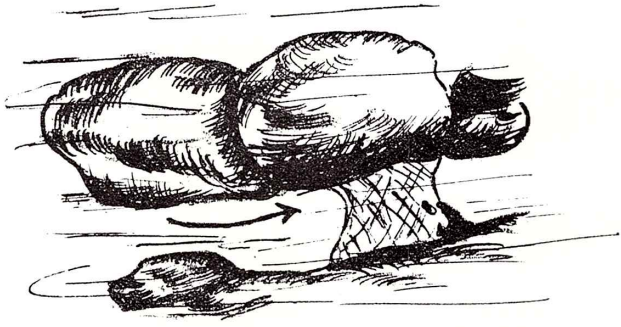
Adults, grey; sluggish night flyers. Life cycle may last more than 1 year.

Adult

Trichoptera Order
(Hair wing) Caddis Fly
Uncased Caddis Larvae
(Free—Living—3)
1. *Stony-Cased Caddis.*
(Hydropsyche)



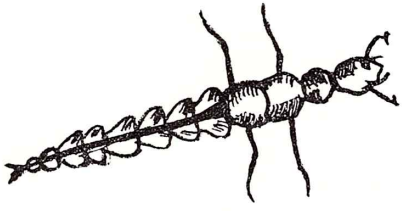
CADDIS LARVAE



"Fishing Net" of Stony-Cased Caddis.

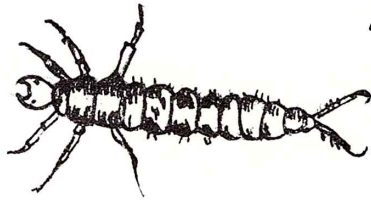
May be found living free, or in a house of debris or pebbles, joined with silk, on the under sides of stones. Very common. Curls when touched.

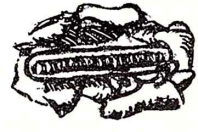
"Fishing Net", as shown is difficult to see. Acts much like a spider's web collecting debris etc. brought down by the current. Tufted gills along the side; hooks and bristles at the end. Eaten by trout. Black pupal case in stone house.

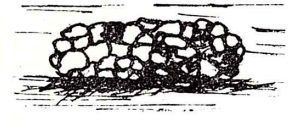


Green Caddis (Hydrobiosis)

Swims rapidly among stones in clear swift streams. First pair of legs are pincers. Carnivorous (mayflies etc.). Biting jaws. Pale brown and green body. Will not live in captivity. Delicate green pupa in a transparent case in an oval stone house.



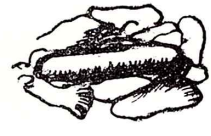




Said to be found in very slow running streams where it forms tubes in mats of algae growing on stones, but possibly has a wider range. Carnivorous; hooks at end.

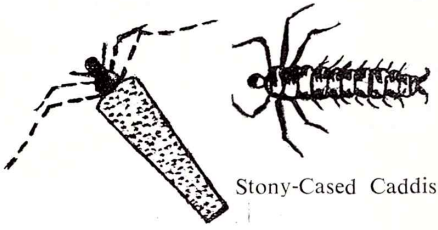
Pink Caddis
(Polycentropus)

Pupa is in a tough silken cocoon in a stone house.



Cased Caddis Larvae

The majority of the 95 species so far named in New Zealand have cases of some type. Many are open at both ends allowing a current of water to be swept through the case past the gills. Hooks at the end of body and processes at the beginning of the abdomen keep the larvae in position. When pupating the ends are closed. Probably most are vegetarian.



Stony-Cased Caddis.

Lives on mud or sand in sluggish water. Browses algae. Eaten in large numbers by trout.

Case secreted by larva. Widespread but more numerous in still water. Hides under stones and sticks. Browses on algal film on stones. Water current through case can be demonstrated by a drop of colour (e.g. Indian ink).

Stick Caddis 1in-5in.

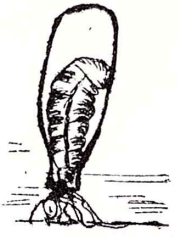
Horny Cased Caddis (Olinga)

Found in perfect camouflage in a hollowed stick or in a case made of large pieces of vegetation joined together. Tends to be in slow water where it clings to the surface stones, logs, or weed. The elongated third legs act as grappling hooks. Food is plant debris e.g. leaves. Hardy in captivity if fed (leaves).

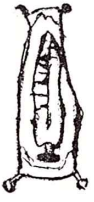
Spiral Caddis 3/16in.
(Helicopsyche)

Looks much like a pond snail but the case is made of cemented sand grains. It browses algae on the stones. Eaten by trout.

So tiny this type is rarely noticed. Usually found amongst filaments of algae or on larger weeds. The case is horny and transparent.

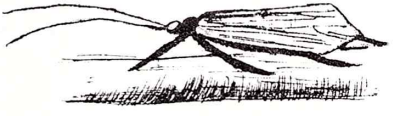


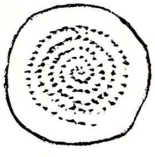
Oxyethira 2.5 m.m.

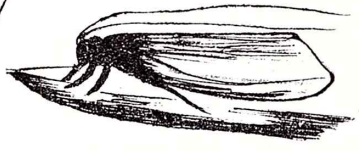


Pupa

Life Cycle
Eggs laid in water to larva to pupa to adult

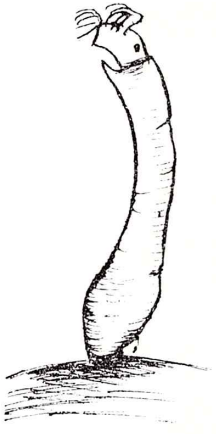


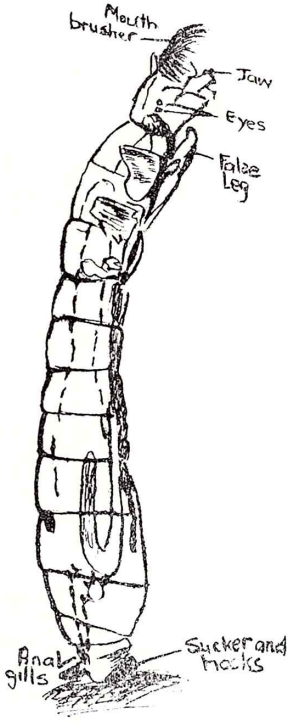




Adults—vary greatly in size but all are moth-like and fawny- coloured. Antennae are long, carried forward or arching over the body. Wings (4) are covered by hairs—instead of scales like moths—and have an obtuse angle in them. They are attracted to lights at night.

Diptera Order—Flies (two winged)
Simuliidae Family—Sand-flies



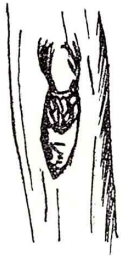


SAND-FLY LARVAE

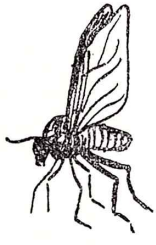
Found on top of rocks or weed in swift water. Silk threads are spun over the rock, providing perches for the hooks at the base of the larva. This silk is also used for a "safety line" which can be let out, allowing the larva to climb back against the current. Two feeding fans strain the water for food particles.

Life Cycle

Egg to Larva to Pupa Adult



Pupae

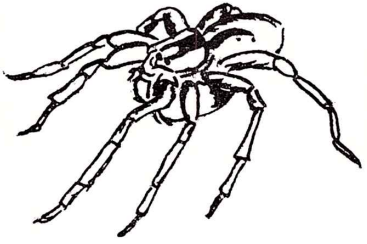


The pupa cements itself to a rock or weed. Two thoracic gills project into the water.

A bubble of air is collected gradually and on "hatching" carries the adult to the surface—dry.

For other insects see the Pond Section.

ARACHNIDA—SPIDERS AND MITES



"Water Spider"

No true water spiders are found in New Zealand though some are commonly found at stream margins and may retreat underwater if menaced. The most unusual is the large hunting spider Dolomedes—the nursery-web spider.

Air is trapped by the hairy body giving it a silvery appearance and enabling the spider to cling to stones underwater for a considerable time.

Carnivorous but with a small mouth for sucking liquids from prey. Carries egg sac for a short time before building typical tent-like nursery on the tips of broom, or on stones.

CRUSTACEANS

Lobster

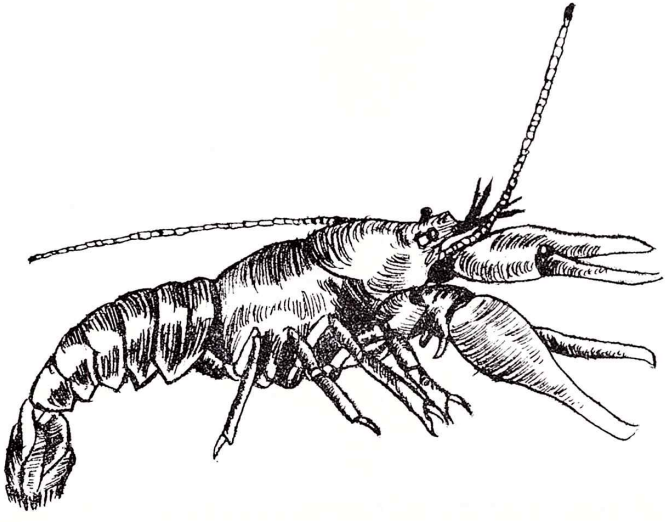
Correctly called the Fresh-water Crayfish

Hides under stones and in pools of streams and reservoirs. Four pairs legs; long and short antennae; stalked eyes and pincers.

Seems to eat mainly vegetable matter and some dead animals. Walks about except when alarmed when the tail is flapped, driving the animal backwards.

"Swimmerets" under the tail—when "in berry" large red eggs are attached and later young lobsters.

A **small** specimen may be kept in captivity but they require well-aerated water (or large surface area) and regular feeding, e.g., with meat dangled on a string for half an hour several times a week.

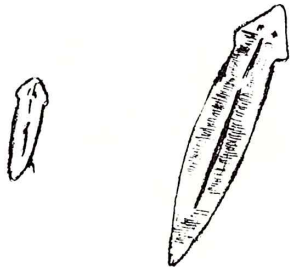


FLATWORMS (Platyhelminthia)

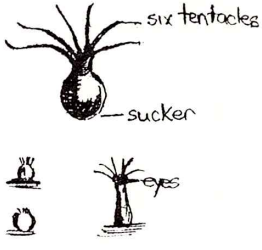
Found hiding away from the light under stones, sticks and old leaves. Glides smoothly along on secreted mucus with cilia beating on the underside, and muscular contractions.

Has two eyes; one body opening—the mouth—about half-way down the underside.

Carnivorous — engulf food, if necessary ejecting pharynx to do so. Hermaphrodite. Eggs laid in a yolk-filled, round capsule.



Flatworms or Planarians



Tentacle Flatworm (Temnocephala)

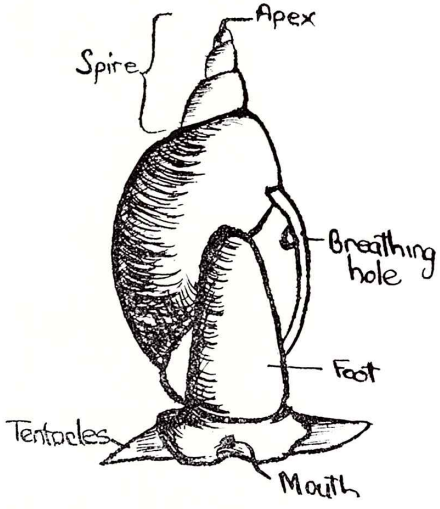
Commonly found attached to a lobster's body, particularly about its pincers but is not parasitic.

The yellow-grey eggs are almost the size of the lobster's red ones and may be seen attached to the latter's body.

MOLLUSCA—SHELL FISH

Univalves Gastropods (one shell)

There are a number of different univalves in New Zealand but most have no common names and tend to have variable shells. An obvious division, however, can be made between the air-breathers (Pulmonates) and gill-breathers (Operculates). The former have no "door" to their shells but do have a breathing hole. The gill-breathers have a horny "door" (operculum) and no breathing hole; the water going in at one side of the shell, around the gills, and out the other side.



Typical Form of a Pulmonate Snail.

All the univalves eat vegetable matter, algae in particular. They have horny jaws and a **radula**, like a toothed tongue, which rasps over the rock or leaf surface.

Many species of snail are hosts to one stage in the life cycle of liver or blood flukes. After leaving the snail there is a short, free-swimming stage which then attaches itself to another host (fish, bird, or animal, according to species and stage). It is one of these free-swimming stages of a blood-fluke, in search of its normal host, the Teal duck, which bores under man's skin causing Duck Itch. However, it goes no further and dies after a time.

The great number of snails in any habitat suggests they are important in the ecology of the pond or stream but little appears certain on this. It is probable that fish eat them.

Most native shells are small, many black. The small ramshorn snail is easily distinguished, a light brown, flattened shell. (See also Pond Section).

Ramshorn Snail
(Planorbis)

PLANTS

See Pond Section for floating and emergent plants. Many streams have none of the large water weeds but any fresh water supports a great quantity of "slime"—**Algae** of various kinds. They may be blue-green, brownish or grass green and grow as minute, unnoticed single cells, a fine coating on any under-water object, or as long, thin filaments.

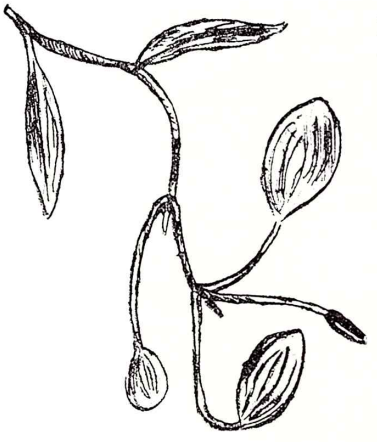
One type of Alga, common in the Clutha basin, forms round "balls" of various sizes. They are erroneously called "frog's eggs".

Algae are basic in the food chains of running or still water.

Problems and adaptations of submerged flowering plants are fascinating. The current tends to whip stems and leaves about but these differ markedly from land plants. The leaves tend to be long and strap-like or finely divided; the stems have the little woody tissue they possess near the centre, leaving them pliant and buoyed only by the current and the large air cells inside the stem. Stems emerging from the water are woody on the outside, like land plants. Some plants have submerged and floating leaves, the latter being broader with stomata (breathing holes) on the upper side (c.f. underside in land plants).

Pollination is normally effected by flowers above the water but the seed is drawn underneath the surface to mature.

Depth of water (light for photosynthesis) and bottom surface largely determine plant growth.



Several species are common most with long submerged leaves and oval floating ones. Veins in the leaves are practically parallel and very noticeable but on underwater leaves have a honey-comb effect.

The rusty colour, flowers and fruit (both rather inconspicuous) are the surest identification. Ducks eat the fruits.

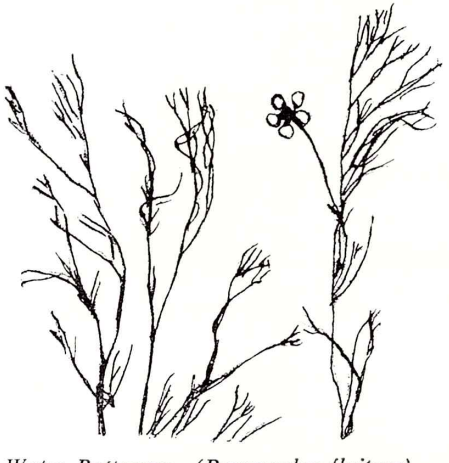
An introduction from East North America. From the Avon it has spread rapidly but is not in all parts of New Zealand. A similar native weed remains green only at the growing tips whereas Anacharis is green along the stems.

Potamogeton
Pond weed
Copper weed

In winter frosts may cause it to die back to the tight winter bud—very easily rooted. It is doubtful if both male and female plants are in New Zealand—increase only vegetatively? One of the main weeds for aquaria.

Winter Bud

Canadian Pond-weed
Anacharis;
oxygen weed

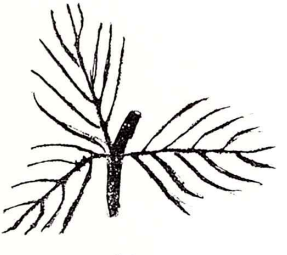


Water Buttercup (Ranunculus fluitans)

A very finely divided plant of swift water. It remains completely submerged except for the small white flower with a yellow centre. It is often called Water Crowfoot in this country but the British Crowfoot appears to be another species which has floating leaves as well as submerged ones. A native of Europe and North Africa.

Whorls of finely divided leaves are usual in these species but they may be rather variable and even have entire leaves floating on the surface.

Flowers are rather inconspicuous and separate. Feathery long stigmas and large anthers are adapted for wind pollination.



Water Milfoil

Grass-green **starwort** may be found submerged but is much more common at the margins.

POND OR SLOW-MOVING STREAM

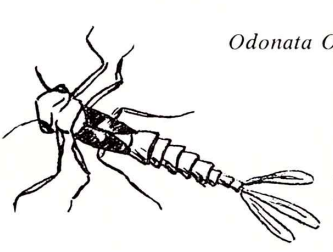
Conditions differ markedly from fast-flowing water. The problem of being swept away by the current is no longer a primary one. Oxygen supplies, however, are limited and more plants and animals depend on the air at the surface.

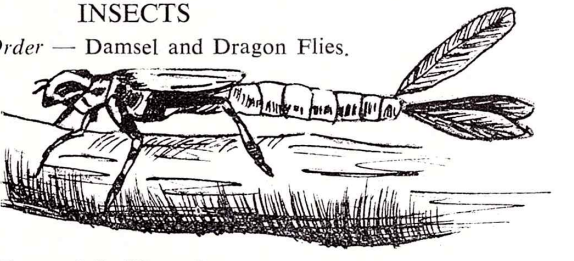
Temperatures vary more in pond than flowing water for although life continues even under ice, the smaller creatures in particular are not in large numbers until the water is warmer—say 55°F. mean.

A special group of animals live in temporary ponds which may even be observed by taking some dried mud and putting it in an aquarium. Resistant stages allow them to live until water returns.

INSECTS

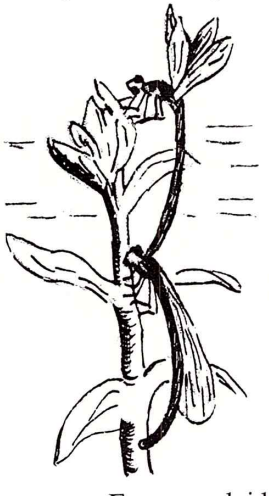
Odonata Order — Damsel and Dragon Flies.

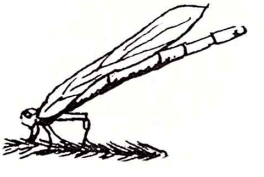




Damsel-fly Nymphs

One of the most common animals found among weeds. Mainly small specimens in winter. Note the three leaf-like gills, large eyes and wing buds. Carnivorous—the jaw ("mask") is shot out to seize prey (see dragon-fly). Live well in capitivity. Large specimens may emerge if vegetation is above the surface.





Life Cycle

Eggs are laid on rushes, raupo, willow, etc., growing in or out of the water. Look for the lines of punctures (eggs inside).

Nymph in water grows by moulting then climbs up vegetation to emerge as bright adult. The sexes differ in colour, e.g., red or blue; blue and green. Small insects are caught on the wing (large eyes; "mask").

The light body, and unequal sized wings held folded when at rest distinguish it from the dragonfly.

Other Aquatic Communities

THE SEASHORE

I — The Sandy Shore

F. D. Jones

At a first glance, the New Zealand coastline—one of astonishing length—appears to be a changeless region. A closer inspection, however, reveals an infinite variety of habitat. We have our rocky reefs with numerous pools, boulders and rocky ledges, all harbouring a myriad of plant and animal life. Marine life, ranging from tiny periwinkles to giant crabs and rock fish is housed in the pools and on the rocks. Sea anemones, coralline growth and sea weeds lend colour to the clear water. When the tide has receded, many of these can be collected for further study.

We move in from our reef to find ourselves on the foreshore. Often, on the open coasts, these foreshores become long stretches of smooth sand, studded with cast-up shells, seaweeds and general débris. This extends up the beach, above the high-tide mark, to be mingled with the flotsam and jetsam bequeathed to the shore by spring tides.

Up we go, until we are climbing the slopes of the rolling, drifting, unstable sand dunes, sinking into soft sand, clutching at stout-looking plants for support, only to find that they seem only too willing to relax their precarious hold, and come away in our hands.

At last we reach the top of our tall dune and stand to look below; out to the reef—interest aplenty there, lots to see and solid ground to stand on. Then to the sandy beach—shells by the thousand, pre-cleaned by the sea, waiting to be collected without fuss and bother.

Now look at our feet and along the undulating wave of banked sand. "What possible interest can there be here for us?" The chances are that you will head straight back to the reef, but perhaps if you stay awhile and really study this shifting, sprawling mass, you will see that the drama of life is being played out here—the eternal struggle of plant and animal for survival against the rugged, wild elements of this area.

THE SAND AS A HOME FOR PLANTS

The desert conditions found on the dunes give us a desert type of plant life. The sand absorbs heat easily but conducts it poorly, so that temperatures are very variable.

(a) Salt

Wind blowing off the sea carries a relatively large amount of salt in the form of salt spray. Inland plants quickly turn black and die if exposed to too much salt spray, but coastal plants seem to

thrive on it. Salt need not always affect the soil as the dunes are formed by wind and as soon as the blown sand is raised above the level of the shore, it begins to be washed out by rain.

(b) Wind

Strong winds are common in this area, as wind plays a big part in establishing dunes. The wind appears to limit plant growth in two ways:

(i) Desiccation by wind-blown sand tearing at leaves and stems (the growing buds of the Marram grass and Sand sedge are well protected to resist this by having several layers of leaf coverings.

(ii) Strong winds accelerate the loss of water (transpiration) from plant leaves. The stunting of Pohutukawa and other coastal trees and shrubs is an example of this process.

The dune grasses, the native Spinifex (found predominantly in the North Island) and the introduced Marram grass both roll their leaves in dry weather and prevent excessive loss of water by sheltering their breathing pores in a microclimate within the curled leaf.

Wind also causes the gnarling and uneven growth of some shrubs by slowing down the growth of new leaf buds on the windward side.

(c) Water

Shortage of water is not as important as it may seem at first. Moist sand can usually be found a few inches beneath the surface. even in the hottest month. The drying out of the surface layer is particularly damaging to seedlings, so usually only adult plants are left growing during the summer months. It is well to remember that the larger the particles that make up the soil, the less easily soil water is retained. Sand does not contain enough small particles to retain much water in its surface layer. You will probably have noticed that some of the dune plants possess fleshy or succulent leaves. The large, triangular leaves of the African ice-plant show this well. (Try burning a portion of this plant and you will appreciate its water content.)

(d) Soil

Sand is generally deficient in many mineral elements. Often, if these minerals are present, they are leached out by the rain, and most of the plants have roots that spread over a wide area in search of food. Soil nitrates are lacking as there is little humus present to enable bacterial action to be carried out. The Tree Lupin of California (found on the more consolidated dunes) overcomes this problem by producing bacterial nodules on its roots (as do other members of the Legume family). The leaves are soft and finger-like, but under dry conditions, droop and fold, exposing only the hairy lower surface to the drying winds.

THE SAND AS A HOME FOR ANIMAL LIFE

Like ourselves, animals need a home for protection, shelter and warmth.

Some notably, the ground beetles, slaters, certain moth caterpillars and the much maligned *Katipo Spider* have found in the Marram grass stems a suitable home. Here they have protection from the scorching heat of the sun on the sand during the hot summers—a condition under which most insects would quickly sizzle and die. The all important moisture supply is retained under the drooping leaves of the grass, especially when they have become matted and half buried in the sand. Though most of these Arthropods, or joint-legged animals are specially suited, with their impermeable, outer coat, to withstand water loss, their food must contain a small amount of moisture. Protection from their aerial enemies, the Harrier Hawk and the roving Gulls, is also found amongst the plants.

It can be seen that the heat and light of day would be distasteful to these smaller animals and it will be found that most of them are darkness dwellers, i.e.g Nocturnal ground beetles and slaters. An exception to this is the little grey and white *Sand Spider,* which may occasionally be seen scuttling across the sand. They are often only discovered when they move, so well camouflaged are they against the grains of sand. They are excellent little animals to keep in a sand terrarium as they are always active and seldom go underground, except to build their small, silk-lined houses just under the sand.

A few specialised animals, the *Sand Scarab* and *Sand Hoppers,* have made their homes in the sand itself. The large, white larva of the Scarab, which is often confused with the Huhu grub, but differs in having more distinct legs and by not tapering at the posterior end, is frequently found one to three feet below the sand, usually at the base of brush fences or Marram clumps. How does it burrow into the sand? This is interesting to watch: it has no appendages on the rear end, so burrows in a spiral fashion, always pushing the sand towards the centre of the spiral. The large, ferocious looking adult beetle, recognised by its glossy brown colour and the fact that the abdomen extends beyond the wing-cases (eyltra), is abroad at night, scavenging, but usually disappears beneath the sand soon after daybreak—to escape the early rising gulls. It leaves behind it a deep, distinctive trail in the sand, ending in a shallow depression. Sometimes the track ends abruptly and the large webbed imprints of a Gull show that it left its withdrawal too late. At other times, the empty shell of the beetle may be seen lying in the hot sand where it has met a slower death. The beetles mate under the sand and lay their eggs amongst marram grass roots in October or November (look for white structures the size of sweetpea seeds). The grubs emerge in late Novem-

ber, and pupate in January, 1 to 2 years later, quite deep in the sand (1½ to 3 ft). The beetles emerge in April or May but remain deep down until August, when they begin to live at about 6 inches, emerging and flying on clear nights.

COMMUNITIES AND FOOD CYCLES

It is noticeable that living things, both plant and animal, tend to live in communities, gaining mutual benefit from the association.

Let us take a look at some insect communities. The leaf eaters (caterpillars, slaters), are directly dependent on the growth of the plant communities for their survival. The flush of Spring growth also brings an increase of herbivorous insects. Similarly, the meat-eaters, the Carnivorous Ground Beetle and the spiders, increase in proportion to their food supply. The *Katipo Spider* is one that is commonly found inside the Marram grass clumps, towards the base of the stems. It is readily distinguished by the round, shiny black abdomen (¼in. diameter) and the red stripe running lengthwise towards the rear. The male Katipo is slightly smaller than the female. The web is of the cobweb type; very tangled and sticky and quite close to the ground, but the spider catches its prey largely by hunting it, nocturnally rather than through the day. Its quarry appears to be usually beetles and slaters; their empty shells are often an indication that a Katipo's lair is nearby. The female builds a round, yellowish egg sac from which the young emerge during February or April, and she appears to keep quite a close watch on it. It has been observed that the young spiderlings take about two months to hatch out, and that they feed on one another. It is interesting to note that the spiderlings hatch out in a variety of colours, usually with a black and white chequered pattern, which the male does not appear to lose completely, only the female developing the distinct red stripe.

An animal with a much larger diet, the common Lizard or Skink, will sometimes be seen scurrying across the sand, or else be disturbed from his burrow under a Cat's-ear plant. You have to be fairly quick to catch him, as he slides between the leaf stalks so silently and swiftly.

COMMUNITIES OF THE FORESHORE

We may take the foreshore for this purpose as extending from highwater mark to high spring tide, or where the first line of vegetation starts. This is probably the most unstable part of the seaside as far as plant and animals are concerned. At times it may support a considerable animal population, especially after a violent storm, when piles of seaweed and débris will be found, swept up in piles. Crabs, shellfish of various kinds, barnacles, jellyfish, and various interesting seaweeds will be found. But in a few days, most of these will have either died or crawled away. The scavengers of the foreshore will then be seen at work. The large Black Backed

Gull and its smaller coastal relative, the Red Billed Gull, may be seen picking their way through the débris in search of titbits.

Under the decaying heaps of seaweed will be found hordes of shiny grey Sandhoppers sheltering and feeding there during the day, only coming out of their tunnels at night. If you look a little more closely, you will find that there are two types, one a little darker in colour than the other. But the best way to tell is to kick aside a patch of seaweed. There will be two reactions, one lot will leap up into the air, the others will scuttle along the sand. The acrobats are Amphipods, the scuttlers are Isopods. Have you noticed them bouncing against your legs at night when you are walking along the beach? Like many Crustaceans, they are omnivorous, feeding on decaying animal and vegetable matter.

The Sand Scarab is a common visitor here, but usually all that is seen are his meandering tracks, left after his foraging journey the night before, and he will now have retired to his home deep in a dune.

The shining black native Earwig is found frequently under logs or decaying seaweed. These native Earwigs are wingless, compared with the more common European Earwig, which is brown. It feeds on the decaying seaweed and small crustaceans. The abdominal forceps are always uneven in the male. The female makes a small cell under a stone or stick for her eggs, and watches over them until they hatch out. This maternal habit is an unusual feature in the insect world.

Reference

"NATIVE INSECTS OF N.Z.", D. W. Miller.
"NATIVE ANIMALS OF N.Z.", A. W. B. Powell.

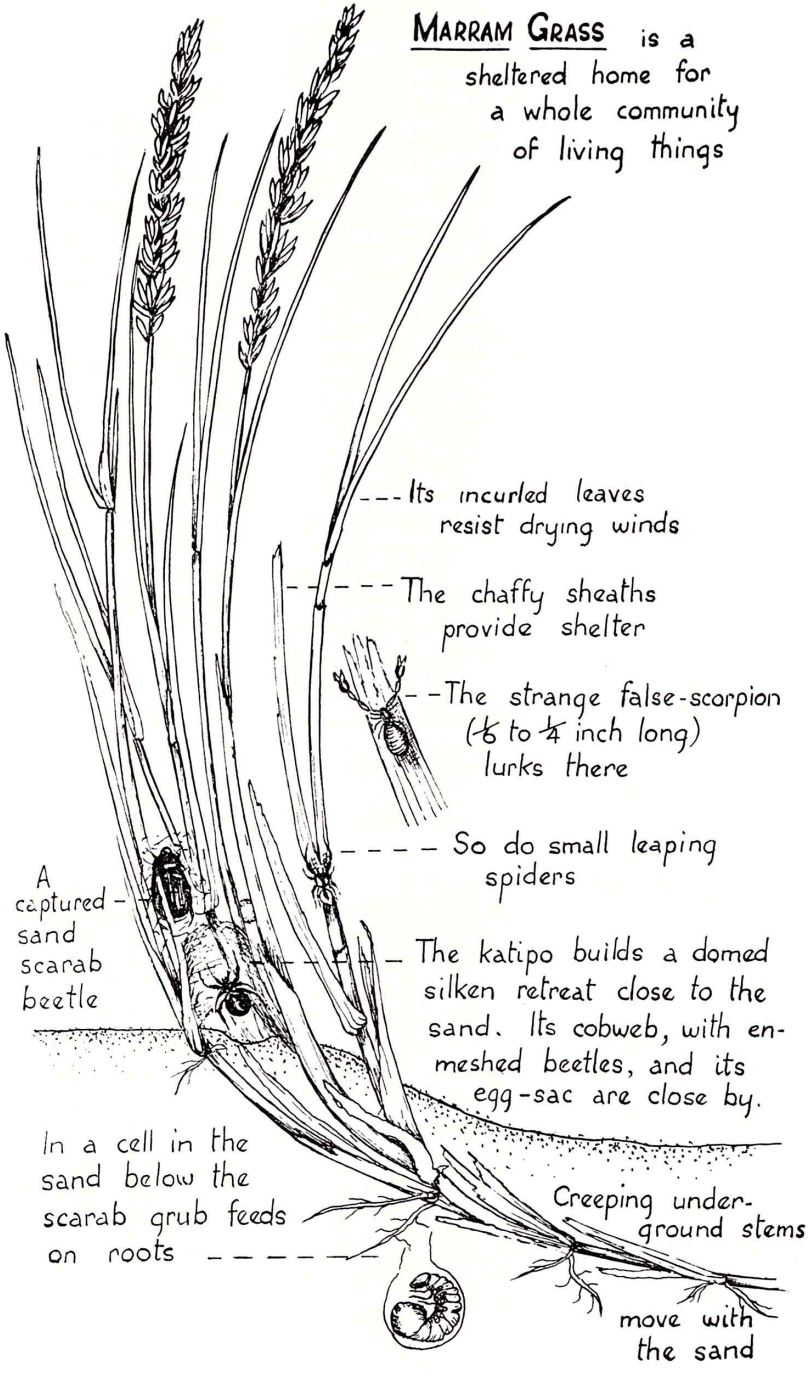
Rarer, but none the less interesting are the birds which choose the foreshore or the dunes as their nesting site. The little Banded Dotterel may be seen running helter-skelter above the high tide mark in search of small animals. It nests on the dunes. About September it lays three green-grey, dark spotted eggs in a sandy depression. As with most ground birds the chicks can run quickly and are protectively coloured. Dotterels are best observed by sitting quietly near a bird, when it will probably approach quite close.

The Pied Stilt, the slender, long-legged bird of the mud-flat with the puppy-like yap, is sometimes found nesting on the dunes in the North Island. And on most sandy beaches the handsome Pied Oystercatcher, with long red bill, is a frequent visitor.

COMMUNITIES OF THE DUNES

The background here is more stable than that of the foreshore.

Marram grass is the prominent plant. In its shade can be seen growing Lupin seedlings, the rosette plants Hawksbeard and the hairy, lobe-leafed Cat's-ear, the long awned Barren Brome and Hare's-tail grass. Not far away Sand Pimelea and Manuka are growing sturdily.


MARRAM GRASS is a sheltered home for a whole community of living things
Its incurled leaves resist drying winds
The chaffy sheaths provide shelter
The strange false-scorpion (1/16 to 1/4 inch long) lurks there
So do small leaping spiders
A captured sand scarab beetle
The katipo builds a domed silken retreat close to the sand. Its cobweb, with enmeshed beetles, and its egg-sac are close by.
In a cell in the sand below the scarab grub feeds on roots
Creeping underground stems move with the sand

This plant community acts as a home for an active, thriving animal colony. These two co-exist to such an extent that one cannot be made mention of without the other. The animal life noticed here includes Silverfish, the introduced Cockroach and Earwigs, but found only in fairly small numbers. Slaters are by far the most dominant animal. Also to be found here is a species of moth with an interesting life history. The adult moth lives and lays it eggs on the Marram grass. The green and cream caterpillar may be found by day at the base of the grass. It feeds by chewing the grass leaves and stems. When the time comes to pupate, the caterpillar makes for itself a stout, oval case of sand, bound together with saliva. These pupal cases may be found around the grass base, but they have to be collected with care as they are fragile and will break and crumble if too much pressure is exerted. They may be kept to watch the dull grey adult moth emerge through a hole in the apex of the cocoon.

Occasionally, another small creature may be found — the *False Scorpion.* It may be because of its size that it is overlooked. making distribution of numbers difficult to ascertain. It is orange-brown in colour, with black "claws" (large in proportion to body size) on the palpi or hands. It has eight walking legs. The jaws are equipped with a poison claw or fang, which hinges back onto the jaw. The False Scorpion is, however, best recognisable by its small size and its habit of running backwards.

EXPLORING BY THE WATER'S EDGE: WHAT CAN WE FIND WHEN THE TIDE IS OUT?

After the exuberance of our first climb to the summits of the dunes, let us take advantage of the tide and, with bare feet on the cool, moist sand, explore the area where animals can live only by burrowing. Here below the sand they escape the rip of the breakers when the tide is high, and the scorching rays of the sun when the waves recede.

But before we rush downwards to the water's edge, let's gather together for a moment about some of this flotsam and jetsam that lies between. Dead burrowers have left their shells here, and a five minute scavenger hunt will give us a heap of bivalves. If we draw circles on the sand, one for each sort, we shall have a circle with tuatuas (write the name on the sand, for they are usually misnamed "pipi"), one with triangle shells (four together make a circle), others with trough shells ,and ringed dosinias. If the beach is sheltered, we may have cockles and pipis; if it is exposed a sprinkling of lance-shaped mactras or of scimitar-shaped mactras. There may be colourful sunset shells and purple razor shells, purple cockles and frilled venerids, morning stars and wedge shells. If our beach is exposed to the prevailing westerlies, or if strong inshore winds have been blowing for days, there will be

interesting "finds" besides the bivalves. These are the pelagic creatures whose house is on the water's blue surface—fragile violet snails, jellyfish, and such old salts as the Portuguese man-o'-war and the By-the-wind sailor.

The home of the live burrowers is further down, where they rest with their shells in the moist sand and their siphons extended to meet the water above. One of them may be unearthed by the age-old method of digging for "pipis". So down to the water's edge to look for the depressions left by their siphons—and dig! When we find a few live tuatuas, a race between the best burrowers will lead to much excitement and show us how the muscular foot works. A "tallest on the right, smallest on the left" parade of shells, with some counting of growth rings, will give us some hint of how they grow. Don't neglect to compare the white, limy, sun-scorched shells of the high water level, their coloured epidermis removed by erosion, with the 3-layered live shell to find out something about shell structure. Look for the muscle scars which tell you how the shells close, the leathery ligament which pushes or pulls them open, and the patterned hinge teeth which ensure a good fit when the two valves clamp together.

Other diggings in the right kind of place may reveal the tunnel of the strange burrowing prawn or the mound of the flat sand dollar. In any case, there will always be the challenge of those tiny holes further up in the moist sand, and another digging race to find the digger—our friend the sand hopper. Put him on the sand, and watch to see how he does it, and to try to find out why. Like his crustacean relatives, the crab and the slater, he breathes through gill plates, and these must be kept moist. If the tide carries him beyond the line of stranded kelp he must burrow to escape a dry death.

These exertions on the moist sand are exhilarating, but tiring. If a strong sea-breeze is blowing, they may leave us shivering. The whole class will be in a mood now to retire to the more sheltered dunes, and the less exciting, but still interesting, populations of the marram grass and yellow lupin.

CONDUCTING A FIELD TRIP

Methods of Working

Group work methods could best be applied when studying the area. There are three main ways in which group work could be undertaken:

(i) Each group or team studies a different aspect (e.g. animal or plant community, bird life) and makes out a report of its findings, to be read to the other teams so that a complete unit is built up. This method is best used if time is not too plentiful—each team becomes an expert on one aspect.

(ii) This method is calculated to give the class a more general view. Divide the area off as for (i), but move each team around the "stations", giving them a set time at each one. "Station" cards with a little general information, sketches and a few questions to direct observation could be left at each station.

(iii) Each team is allocated a typical dune and makes its study of that area. In this way, different plants and animals may be noted as being dominant in the various areas, thus giving a truer, overall picture of the area, and communities in general —they all look the same, superficially, but what a difference if we study a little deeper.

Observational cards should be given to each team, to direct them towards specific observations.

Reference

N. S. Bulletin, Vol. 5, No. 3, 1955, for method.

Handbook of Nature Study, D. Beggs, for compiling questions, etc.

A CLASSROOM DISPLAY

For further observation of the different animals, e.g. how they live, feed and grow over a period, a number can be taken back to the classroom and set up in reconstructed habitats, perhaps in screw-top jars, containing sand and a little marram grass. Plants could be taken back and arranged as a display on the Nature Table. Plant them in a tray filled with moist sand. A specific one could be incorporated as the Plant of the Week.

Equipment for Collecting

1. Shovels or trowels for digging for underground grubs, beetles, etc., e.g. Sand Scarab larvae at base of plants or brush fence.
2. Glass jars or small boxes for insects and spiders.
3. Plastic bags for plant specimens.
4. A tin (say, a biscuit tin) for transporting plants and moist sand for the construction of indoor homes in the classroom.

What to Collect

1. Plant specimens for display, Plant of the Week, pressing, shelter and food for the animals collected.
2. Animals best to keep—for classroom purposes, the nocturnal or truly underground animals are not suitable for study.
   Spiders: Katipo and Sand.
   Earwigs: Native and introduced.
   Slaters.
   False Scorpions.
   Lizards.
   Moth caterpillars.

Setting Up

Open plastic boxes (large, lunch box type) serve the purpose well as they are fairly deep, for Sand spiders, Earwigs, Slaters, False Scorpions. Put a covering of sand and straw in the bottom. Moisten the sand occasionally.

Large Agee bottle, turned on its side and fastened to a wood base makes an effective Spider bottle for Katipos. Have a gauze lid inserted. Caterpillars can be kept in an insect box, or glass bottle (as for Spider bottle). Lizards may be kept in a lizard terrarium, or an insect box with a fitted metal tray. See *Nature Study Handbook,* D. Beggs, for this point.

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FLORA OF THE DUNES

FORESHORE

Occasional plants that have germinated in the flotsam and jetsam but do not live long.

DUNES

(a) Sand Binders

Golden Sand Sedge (Pingao)	Desmoschoenus spiralis
Silver Sand Sedge (Spinifex)	Spinifex hirsutus
Marram Grass	Ammophila arenaria

(b) Sand Collectors

African Iceplant	Mesembryanthemum edule
Native Iceplant	M. australe
Sand Convolvulus	Calystegia soldanella
Harestail Grass	Lagurus ovatus
Sand Pimelia	Pimelia arenaria

(c) Shrubs

Matagowrie	Discaria toumatou
Native Broom	Carmichaelia flagelliform
Small-leaf Pohuehue	Muhlenbechia complexa
Manuka	Leptospermum scoparium
Golden Cottonwood	Cassinia fulvida
Bracken Fern	Pteridium esculentum
Tree Lupin	Lupinus arboreus

PINES

Pinus radiata	P. muricata

OTHERS WHICH MAY BE FOUND

N.Z. Spinach	Tetragonia trigyna
Jointed Rush	Leptocarpus simplex
Sea Rush	Juncus maritimus
Common Flax	Phormium tenax
Mountain Flax	P. colensoi
Cabbage Tree	Cordyline australis
Korokia	Corokia cotoneaster
Toe toe	Arundo sp.
Pampas Grass	
Barren Brome	Bromus sterilis
Bent Club Rush	Scirpus nodosus
Sand Coprosma	Coprosma acerosa
Poroporo	Solanum aviculare
Bachelor's Button	Cotula coronopifolia

Reference

Our N.Z. Trees and Flowers. E. C. Richards.
Our Living Environment—Sand Dune Plants. Post Primary Bulletin, Vol. 3, No. 4.

FAUNA OF THE SAND DUNES

FORESHORE

Sand hoppers	Birds:
Kelp flies	Black backed gull
Native earwigs	Red billed gull
Sand scarabs	Banded Dotterel
Sandflies	Oyster catcher
	Starlings and others

DUNES

Spiders:	European cockroaches
Katipo	Lacewings—adult and larvae
Sand dune wolf spider	(ant-lion)
Leaping spiders, and others,	Lizards
but mainly the above	Moths and caterpillars generally

Slaters
Earthworms
Sand scarabs—
larvae especially
Carnivorous ground beetles
False scorpions
Silverfish
Rabbits
Hares
Deer
Birds:
Kingfisher
Harrier hawk
Finches

II. LET'S EXPLORE THE MUD FLATS

W. C. Clark

The fascination that the rocky shore holds for mankind is known and appreciated by many, and is reflected in the number of books and learned papers that have been published about it. Few people have realised that as a field for nature studies the muddy or estuarine shore also has much to offer. Many school teachers rue the fact that there are no rocky shores within striking distance of their schools, but are deterred for various reasons from venturing to use the mud flats that may be available. There are many reasons for this, not the least of which is the fact that very little information is available to teachers on this interesting habitat. It is hoped in this article to provide a basis of factual information which will encourage teachers to explore this habitat with their classes. The techniques used in study are similar to those outlined in an article on the rocky shore.

ORGANISATION

Class visits to mudflat areas are best made after a preliminary visit by the teacher. This earlier "survey visit" will make him familiar with the area and the forms that are to be found there. It will also be useful in gaining knowledge of particularly soft patches which may then be avoided. The class field trip should only be undertaken after the class has been given due warning, and the children have equipped themselves, if thought desirable, with some old footwear which will provide some protection against the sharp edges of shells. A sharp look-out for broken glass is also advisable.

Equipment taken on the trip should include jars for animals collected and a spade to help in the collection of burrowing forms.

Other points to remember are (1) low tide in an estuary is often a little later than on the open coast, and (2) mud splashes on clothing should be left to dry and then brushed off. Any attempt to sponge them off whilst still wet will only make the matter worse.

THE ENVIRONMENT

Mud flats are here understood to be those relatively level areas of fine sand and silt that are covered by sea waters of various salinities at high tide and uncovered to varying extents at low

tides. Such mudflats are of two main types: those found in sheltered bays and inlets where the water that washes over them is, for practical purposes, sea water of normal salinity, and in estuaries at the mouths of rivers and streams. In the latter case the sea waters that cover these flats at different stages of the tide may be considerably diluted. These two types of flat differ to some extent in other respects, probably as a result of this physical feature. Some animals and plants are not capable of tolerating such ranges of salinity and so are not found on certain estuarine shores.

Problems of life on muddy or fine sand shores differ somewhat from those found on rocky shores. In the latter case the chief problems are avoiding desiccation and the maintaining of a foothold in the face of wave action; a further problem is the heating of the rock's surface during the summer. On the muddy shore, however, these problems rarely arise. Desiccation is not so important as the mud or sand contains much water even when the tide falls. The heating effect of the sun is also lessened by the evaporation of some of this water which itself causes cooling. Wave action is slight in these situations and foothold is no longer a matter of life and death. If wave action was other than slight the mud or fine sand would have been removed long ago. Despite this, many animals gain a good measure of protection from all these dangers, and predators as well, by burrowing beneath the surface. The great problem of the estuarine type of shore is that as the tide rises the fresh water coming down the streams is backed up by the sea and the sea water is diluted, and begins to flow out over the previously exposed flats. As the tide rises this water is pushed further and further back into the inlet and is replaced by more sea water which is of higher salinity until much of the area is covered with virtually "normal" sea water. Thus an area may be exposed to the air covered with almost fresh water and then salt water in quick succession. Such changes in the surroundings place considerable strains on biological systems, and the animals that can live here are tough indeed. This of course accounts to some extent for the limited variety of animals that are at first found in this habitat. Even if there are rather fewer forms to be found here than on the rocky shore this is more than made up for by the interest and abundance of the species that are found.

Whilst the effects of the salt water are obvious between normal tide-marks, it is important to notice that the very high tides may have considerable effects on the surrounding land vegetation.

THE LAND PLANTS

Periodic inundation by salt water of the lands surrounding mud flat areas often makes the soil in these places saline and so limits the types of plants that grow there to a few special kinds. Thus the vegetation surrounding mudflats may differ markedly from that found on higher ground. The plant communities of these areas could well be the subject of a special study, or if the class

arrives before the tide is low, they might be examined briefly before going out to study the animal inhabitants of the outer flats. If you wish to study the plant life it must be studied *before* the animals as children usually find it rather dull to study sedges *after* crabs.

Perhaps the most effective approach to the study of the salt marsh type of plant community is to draw analogies with human colonisation of a new area with the attendant talk of pioneers and permanent settlers. In the ideal situation (which is often found), the succession from the sea to the land is something like this:— Standing out often by themselves as a patch of blue-green "rushes" is a sedge Three-square. The "three-square" really applies to the stem on which the flowers will appear which is triangular in cross section. The leaves are sharply angled about the stems, and rather less conspicuous. This colony of plants is an important "pioneer" as the stems and leaves slow down the passage of water and the ground about them slowly builds up, as silt and debris collect, so that other plants may grow there. The rooting system is extensive; to show this a plant may be pulled or dug up. On the landward side of the three square, or perhaps acting as primary colonisers, the Jointed Rush (north of Timaru) and the sea rush may be found. Jointed Rush is easily recognised by the dark scale-like leaf remnants which ring the bright brown, or green stem at intervals. As the sexes are separate in this plant, an attempt should be made to find flower heads of the two sexes, and then decide which is which. The Sea Rush is most easily identified by where it is growing, as it seems to be the only true rush in the country which lives where it is occasionally reached by the tides. These two plants together grow up and exclude the light from the three-square, which then drops out of the picture. The dense stands of rushes trap more debris and silt and as the ground is raised and becomes drier, more and more plants come into the community. A conspicuous plant in the situation is the Southern Glasswort, so named from the fact that the soda-rich ashes of its northern hemisphere relative were used in glass making. This succulent plant has lost almost all sign of leaves which are represented by thin scales at the nodes or joints in the stem. The flowers are also greatly reduced.

Other common members of this zone are Creeping Selliera which has shining green, paddle-shaped leaves and a split corolla, so that every flower looks as if a piece has been torn out of it; the reddish-brown leaved Water-Pimpernel is very abundant in some places, its white flowers often being covered at spring tides. Where conditions are really damp the yellow flowered Bachelor's Button is conspicuous, but this plant is not restricted to salty conditions.

As the land becomes higher and drier a number of other plants become dominant. Under natural conditions in New Zealand the next plant to enter the succession and to take charge is the Salt Marsh Ribbonwood, a dull, low shrub, bushy to the ground, with many twigs but few leaves. Because of the stringy lace bark it is very difficult to break pieces of this shrub. In areas where man

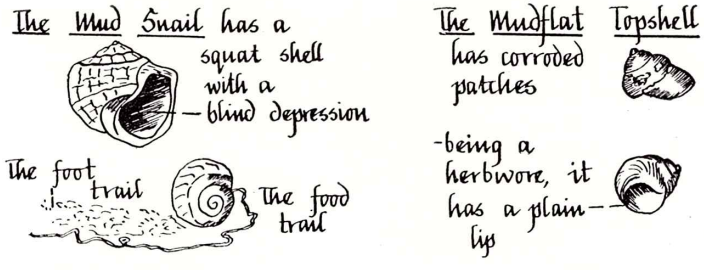
has interfered with the natural succession instead of, or between the ribbonwoods we now find plants like Sea Barley Grass, a small grass not unlike ordinary barley grass but with a much smaller seed head and Buck's Horn Plantain which is similar in the seed head to ordinary broadleafed plantain or ribgrass, but the leaf is much divided and rather antler-like. A plant often sown in this type of area is the salt tolerant Strawberry Clover.

It is important to notice that all of these plants have some device for conserving water or reducing water loss by transpiration. Some like glasswort, and the rushes have very small leaves and the stems have taken over their job to a large extent. The leaves or stems may have a thick or waxy cuticle which acts as a water-proofing, or a covering of hairs which, by creating a thin layer of still air about the plant, assist in water conservation.

THE ANIMALS: MARKS IN MUD

The first animals found as one moves out onto a mudflat vary somewhat from place to place, depending mainly on whether or not a zone of stones or boulders marks the upper edge of the tidal area. Such stony areas often support a group of intruders from the rocky shore such as barnacles, dark or spotted topshells, half crabs and chitons. As these animals do not really belong on the muddy shore they are not discussed here.

The sand or mud of the flats is easily disturbed by the animals which live on or in it. In fact one might say, "by their marks you shall know them." Here an attempt is made to give an account of the common animals of the mud flats by first describing the marks they make, and then saying something about the animals themselves. The marks are of three main types: trails, craters and mounds.



Trail Makers:

The trail makers come first, as the animals are easily found. On the upper part of the shore one commonly finds double tracks; the most obvious is a fine cylindrical strand of mud or sand, often looped back on itself, and frequently broken for short distances. This strand is always accompanied by a wider, and less distinct trail which is sligtly depressed into the sand. If these trails are

followed up a squat, brownish snail will be found. This is the Mud Snail or Titiko. If you have the right animal, underneath and behind the aperture of the shell you will find a small blind hole. The mud snail is a hardy creature, it will withstand total immersion in fresh or salt water for a fortnight without showing any ill effects. But whence the double track? If you are patient you might see these being made, but the animal moves slowly. The broad shallow track is made by the foot as the snail crawls along. The other trail is concerned with feeding. The mud snail feeds on minute single celled plants that are to be found (if you have a good microscope!) on the surface of the mud. As the snail crawls along, the surface layer of mud is picked up by the conveyor-belt-like "tongue" of teeth and passed into the mouth. In the stomach the plant material is sorted out and kept to be digested, whilst the unwanted mud is passed out to the right as an almost continuous string. You will get a good idea of how much mud must be sorted to get enough food to keep the animal alive, if you see how long some of the strings are that have been made since the tide went out.

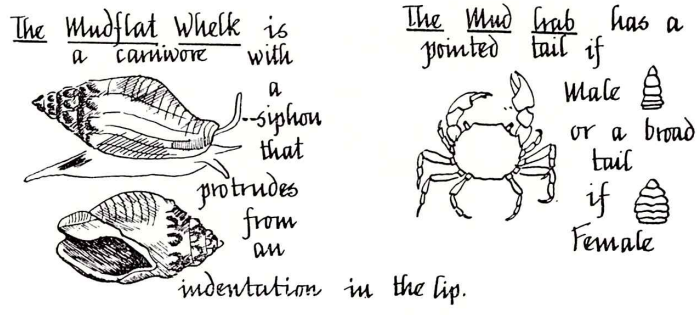
A little lower down on the shore you will find more broad snail-type tracks. Follow them up and see what you find. If the tracks are $\frac{1}{4}$ to $\frac{1}{2}$in. wide you may find a snail which is about twice as long as it is wide, and greyish brown in colour. This is the common Mudflat Whelk, the only really common carnivorous snail on the mudflats. It has many interesting habits; one you may observe is the way in which these animals seem to be able to detect the presence of a dead animal on which to feed. A dozen or more may be found clustering around and feeding on a dead crab. How they find their way there is a mystery. Follow the trails backwards; did they come to the crab in almost a straight line, or did they circle around before getting "on the scent"? This whelk is said to be able to feed on cockles by moving up to the cockle when the tide is in, and its shells are agape, and inserting the lip of its own shell between the valves of the cockle. The cockle responds by clamping down tightly, but sooner or later its muscles tire and the whelk is able to move about and start feeding on the soft parts within.

The other snail that leaves tracks like this is the Mudflat Topshell. These snails have rather squat shells, about as high as they are wide. The colour of them varies a lot. In the northern part of the North Island they may be mostly yellow with purplish spots or patches, but further south they may be mainly purplish with only a few spots of white or yellow. The shells are often rather corroded on the older parts near the top. Mudflat topshells are herbivorous; they may eat microscopic algae on the surface of the mud like the mud snails, or they may eat larger plants like sea lettuce or eel grass. If they feed mainly on the microscopic algae they do not grow as big as when feeding on the bigger plants, probably because they eat so much mud as well which isn't very nourishing. If you examine any number of topshells you will almost

certainly find a number with tiny limpets clinging to them. Unlike topshells, limpets do not appear to be able to crawl on mud, and so need a solid substratum on which to crawl. These little ones feed on the algae that grow on the shells of the topshells.

The Crater Diggers

The largest holes on the mudflats are made by crabs. If the burrows are near the high water mark you may see the tracks that the animals have made in their comings and going from their burrows. The burrows are made by the Mud Crab (*Helice crassa*). The usual view one gets of these crabs is a distant one, as they scurry away and pop down their burrows. Sometimes you can get a good view of them by lying very still on a jetty and looking down on them. The best way to examine them is to push a finger down into the burrow and pull the crab out (it's very small and won't hurt, even if it does try to nip you). Look at its colour . . . is it camouflaged? Is it a male or a female? (To decide this turn the crab over on its back and look at the abdomen—held very closely against the under surface—if this is broad and rounded at the tip it is a female, if narrow and pointed it is a male.) If a female, is it carrying eggs? (These will be found under the wide abdomen). Why do the males not need a wide abdomen? Was there water in the bottom of the tunnel? What would be the importance of this? Living as it does in a muddy environment and

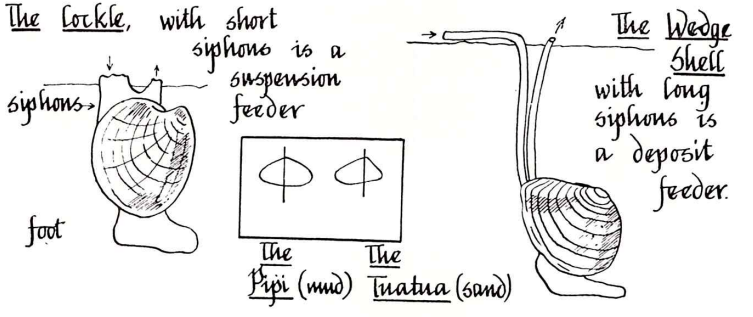

The Mudflat Whelk is a carnivore with a siphon that protrudes from an indentation in the lip.
The Mud Crab has a pointed tail if Male or a broad tail if Female

often crawling about in muddy water the mud crab is likely to get its eyes covered in mud. This would effectively blind the crab as it cannot close its eyes as we can, nor does it have tears to wash the silt away. To overcome this problem it seems that the mud crab invented the windscreen wiper a long time ago, for it uses one of the limbs around the mouth to clean the surface of its eyes. Another crab rather similar to the mud crab is often found half buried in the mud or standing up boldly on the surface. The first thing that strikes you about this crab is the length of the eyestalks. (The eyestalks in the mud crab are less than one-third as long as the width of the carapace, but at least one-third of the carapace width in this other crab (*Hemiplax hirtipes*) which has not got a common

name, but Stalk-eyed Mud Crab might do). This latter crab does not tunnel as much as the mud crab, but will shelter in mud crab burrows. Despite the sharp look-out that the crabs maintain, a lot of them end up as a meal for a kingfisher.

Other craters are made by different animals, and for a start it is necessary to dig under the crater to be sure of what is underneath. Once you have got your eye in there should be no trouble in distinguishing all the kinds mentioned here. Holes about $\frac{1}{4}$in. across with steep sides are often made by the Mudflat Sea Anemone. This little brownish animal is usually found to be attached to a shell or stone buried beneath the surface of the mud. When water covers the animals they are extended with the tentacles waving about in the water above and catching tiny animals by means of stinging cells. (Try feeding them with pieces of mollusc flesh or if they are fairly large touch them gently with your finger and notice the slight "stickiness" which is due to the stinging cells having penetrated a very short way into your skin—it is not in the least painful). When the tide goes out the anemones retract down into the sand or mud and so avoid being dried out by the sun.

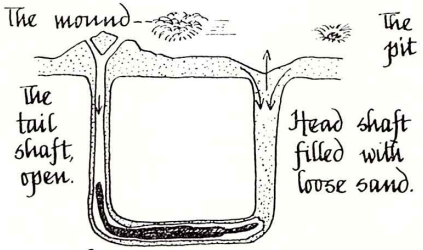
Somewhat similar craters are found over beds of Cockles or Tuangi. Here the craters are made by the retraction of the siphons of this animal. When the area is covered with water the siphons are level with the surface and water is drawn in through one siphon and, after the minute animal and plant life that was suspended in the water has been removed in feeding, the water is passed out again through the other siphon. The siphons of the cockle are very short, and so the animal is found very near the surface.


The Cockle, with short siphons is a suspension feeder
siphons
foot
The Wedge Shell with long siphons is a deposit feeder.
The Pipi (mud)
The Tuatua (sand)

Similar, but usually smaller craters or holes are left by a variety of burrowing worms. These are often exceedingly abundant, but their identification is a job for a specialist. Some are predacious, others herbivorous, but all worth looking at.

Star-shaped craters are often found in numbers. These are not true star-shaped but with a central depression and a number of rather irregular radiating channels $\frac{1}{8}$in. or so deep and about 1in. long. These are what are sometimes called "Tellina marks," because

Tellina is the old name of the bivalve mollusc that makes them. If you dig down 3-5in. you will find a thin white bivalved shell; this is commonly called the Wedge Shell. How are the marks made, and what is it doing so far from the surface? Unlike the cockle, the siphons of the wedge shell are very long, though they can be retracted to a fraction of an inch, and when the tide is in these push up through the sand or silt and instead of sucking in water from directly "overhead" the animal sucks in water and the surface layer of microscopic plants. The radiating spoke-like marks are made where the siphons have rested on the surface. Thus the wedge shell is a deposit feeder, whilst the cockle is a suspension feeder.



The Lugworm in its tunnel.

In sandy places you might find saucer shaped craters with a small vertical hole in the centre; these are the holes of the Burrowing Prawn. To get this animal involves much energetic digging with a spade. You must dig quickly as once you start the animal will start digging too! The only way to do it is to throw the spoil out and let someone else sort through it. If you are lucky you will find an orange red shrimp-like creature about 2in. long with one huge pincer and one very small one. It is interesting to put these in a sandy bottomed pool and watch them bury themselves again, or even better, let them do it in a pickle-jar of sand and water, where if it burrows against the glass you will be able to see it "at home". In some localities you may dig up Mantis Shrimps in this way. These are greenish or pinkish buff 3-4in. long, and with pincers like the praying mantis.

Mound Builders

We need concern ourselves with only two types of mounds. The first one consists of an irregularly coiled strand, and where the mounds are found simple pits are found also. These are the two ends of the U-shaped burrow of the Lug Worm. Getting these worms out whole also calls for some exertion. They vary considerably in size from about 3-8in. and may be either green or pink. The worm itself is easily recognised by its shape, the front half is about half an inch across, and with peculiar tufty gills, whilst the back half is only half as thick and without the gills. The mound

that is seen at the tail end of the burrow is a very large casting similar to the casts of some earthworms.

The other peculiar mounds found on mudflats, usually from January to April, are very different. They are semicircular ribbons of cemented sand grains. Most of the ribbon is not sand, but eggs. These are the egg masses of the Mud Snail. The eggs are laid in these sandy ribbons and left lying on the surface of the mud flats, development proceeds within the egg, and in time a minute free-swimming larva emerges. This spends an unknown period swimming about in the plankton, but after the shell has formed it sinks to the bottom and continues its life in the adult way.

Other Animals to look for

During the late spring and summer months baby Flatfish may be found in shallow pools left by the tide. To be seen they must be carefully looked for as they may be only half an inch long, and their colour blends perfectly with their background. Shrimps may also be found in similar places. The true Pipi *(Amphidesma australe)* not the tuatua *(A. forsterianum* in the south or *A. subtriangulatum* in the north) is often found in great numbers. It is easily distinguished from the tuatuas of ocean beaches by having the hinge centrally placed instead of towards the posterior end as in the latter.

Birds

The birds of mudflats merit an article to themselves, but the following are common throughout New Zealand and may provide a useful guide as to what to expect, or perhaps look for:—black-backed and red-billed gulls; white-fronted and Caspian terns; oystercatchers, stilts, godwit, white-faced heron; black, pied, white-throated, and spotted shags; and on trees and telephone wires around the margins, kingfishers.

Follow-up Activities

Most of the mudflat animals are fairly hardy and may be kept for a week or so in aquaria with an inch of sand on the bottom and no more than ½in. of sea water (collected from the same place as the animals) over this. Some sea lettuce will help aeration. It is a good idea after having put in about ½in. of water to prop up one end of the aquarium and so form a "beach" onto which the animals may crawl if the oxygen gets a bit short in the water. The other rules are the same as in all aquarium keeping: DON'T OVERCROWD, and remove any dead animals promptly. Small flatfish may be kept for a short time in soup plates with very little water, provided the dish is not allowed to heat up in the sun.

Observation notebooks should be kept alongside the aquaria, perhaps stimulated by question cards.

The succession of plants on the salt marsh might be made the subject of a special display using small groups of plants collected at the time of the field trip, well labelled and set up on the nature table.

The following books are useful sources of information:

L. Cockayne, *New Zealand Plants and their Story*. Government Printer (out of print).

Ruth Mason, *Water Plants*. Post-Primary School Bulletin, Vol. 4, No. 12.

Lucy B. Moore, *Sand Dune Plants*, Post-Primary School Bulletin, Vol. 3, No. 4.

Lucy B. Moore, *Coastal Plants*, Post-Primary School Bulletin, Vol. 7, No. 7.

A. W. B. Powell, *Native Animals of New Zealand*. Unity Press.

C. M. Yonge, *The Sea Shore*. Collins, London. See Chapters 16 and 17 on Muddy Shores and Estuarine Shores.

III. THE ROCKY SHORE

PART I. CONDUCTING THE TRIP

Brian T. O'Rourke and the Third Year Group

The seashore is a place of vast interest to both young and old. In its own right it is a home of wonder and surprise. "What is this?" "What does it eat?" are questions that children ask, which if answered may give the seashore added meaning and interest.

The seashore trip can be, as those who have attempted it will know, the Nature Study event of the year. This article has been designed to aid you in carrying out your sea-shore trip. The methods suggested are not final; they are suggestions only. We would be interested to hear of other methods which you have employed successfully.

When

From mid-November to March is probably the period during which the weather is most suited to seashore visits. However, even on the warmest day spare coats and warm clothing are not out of place, especially if the seashore is some distance from school. Try to avoid strong inshore winds which cause big waves.

Try to select a day on which low tide falls somewhere between 11 a.m. and 2 p.m. This will enable you to observe and collect shore life successfully. Spring tides (at new and at full moon) are better than neap tides, as they leave more of the intertidal rocks uncovered.

Beforehand

Add to the class library a temporary stock of literature dealing with seashore life. Books can be obtained from the library service if ordered well in advance. Allow time for the children to look at some of these books. Do not attempt to inculcate knowledge, rather use the printed material as a means of evoking interest.

Prepare for the reception of seashore plants and animals in the classroom. A dozen white, flat, soup plates would not be too many receptacles. White enamel baking pans are better.

Arrange for the children to place the soup plates in a position which is well lighted yet out of the direct sunlight. Explain that direct sunlight not only warms the water making it suffocating for the animals but it also speeds up unwanted evaporation. In addition tiny plants in the water multiply quickly to form a smelly soup if the water receives too much direct light.

Ensure that on the day of the trip as many children as possible bring a large preserving jar with string or wire handles. But watch these on the rocks. Broken glass is as dangerous as sharp rocks; so be sure to include some first aid material in your equip-

ment list. Have stout footwear or tennis shoes, and a coal chisel and hammer to chip off rock with anemones, tubeworms and sea lettuce.

Conservation

In the past it has been the practice to return to school after a field trip laden with as much seashore life as could conveniently be carried. Recently many favourite spots for class trips have become valueless simply because of this habit.

The idea of conservation which is slowly taking hold in other countries, notably the U.S.A., has not been stressed in New Zealand. Our dwindling natural resources are in urgent need of attention. You could make a small step in this direction of instilling a sense of conservation by appointing or having appointed six children to bring back representative samples of animals to the classroom, one of each type. Three others might carry back enough of the common green sea lettuce (readily identified from its lettuce-like appearance), or sausage-like green enteromorpha, to help oxygenate the soup plate marine aquaria. The remainder would return with jars of sand (or shell chip) and clean sea water both of which will be needed in the setting up and maintenance of the aquaria.

The children who are to be the proud conveyors of the animals need carry only two or at the most three animals in each jar. This will mean that from twelve to eighteen animals, more than enough, will find their way to the classroom. The most suitable animals are those found in pools—sea anemones, hermit crabs, tubeworms, prawns, cushion stars, half crabs.

To ensure that there are no fatalities in the jars check the specimens to see that they are uninjured, fill the carrying jars to not more than one quarter of their depth with sea water, make sure that the tops are left open and that the jars are kept out of the sun. Sea animals quickly succumb to a lack of oxygen or increase in temperature so that anything you can do to retain oxygen and prevent the jars from warming up will be conducive to the success of your expedition.

The Whistle

It is often difficult to make your voice heard above the sound of breakers at the beach. Put a whistle in your pocket. The whistle means "Come to me".

At the Beach

Your aim: to let the children familiarize themselves with as much of the life of the shore as is possible in such a limited time.

Try to keep the proceedings reasonably systematic. You will be surprised how much like a picnic the day can be yet how broadening for the child if only the approach is well thought out.

If you have had the foresight and opportunity to preview the area you may lead the party to a good camping spot. Otherwise select a location and settle in. A ten minute free run on the beach helps to let off the steam of excitement and makes your later work easier.

Assemble the class with a blow on the whistle and indicate clearly the area in which the hunt is to take place. Make this area small so that you will remain in reasonably close contact with every child. All the children get to work, looking for animals. Ask each child or group to bring one animal, which you name, back for discussion. The teacher moves about assisting, questioning and ever, where nothing else is possible, answering questions. After a time, blow the whistle. This means "Come back to our meeting place, away from the roar of the waves, and be prepared to give a report on your particular animal." An hour full of discovery will soon pass. During this time, if identification troubles you place animals in classes according to these simple rules of classification. Illustrations will be found in *Native Animals of N.Z.* by Powell.

Crustaceans

1. Crabs—Animals with eyes on stalks and ten legs. The front pair of legs are pincers.
2. Prawns—Semi-transparent—up to 1½in. long in rock pools.
3. Seaslaters—In rock pools. Similar to ordinary slaters or woodlice.
4. Sand hoppers—Under rotting kelp.
5. Barnacles—Look like shellfish but really are crustaceans which have decided to stay put.

Molluscs

1. Single shelled animals—All sea animals having a single curled snail-like shell.
2. Limpets—uncurled single shells.
3. Chitons (pronounced Kyton)—Uncurled shells with eight joints.
4. Double shelled animals—All animals with two shells hinged together such as mussels, cockles, pipis, and oysters.

Spiny-skinned Animals

All animals built on the star plan. This includes the sea urchin.

Worms

Long animals with many bristles.

Tube worms are found in white tubes cemented to rocks.

Hollow-bodied animals

Anemones look like plants but really are animals with stinging tenacles.

Fishes

Animals with fins and scales.

You will find that most animals fall readily into one of these groups. Those which are able to close their shells (mussels, oysters, barnacles) or clamp down on to rock faces (limpets, chitons, periwinkles) will be found high and dry at periods of low tide. Soft bodied anemones will shelter from the drying sunlight under overhanging rocks. Crabs will be found underneath boulders along with chitons which seem to prefer such places at low tide. All will be found in rock pools.

After the Rush

Assemble the children around you making sure they sit in such a position that their jars can be placed in the shade.

Discuss the finds Concentrate on:

a) Adaptations

b) Food-getting.

Seashore animals are adapted to withstand the pounding of waves and the drying effect of sunlight at low tide. Their adaptations take the form of hard coats of various kinds which can be closed or clamped down at low tide and which will protect the animals from a pounding at high tide. Seashore animals except those which live in rock pools feed only at high water. Crabs and seaslaters scavenge; fish hunt minute animals; sea-snails, chitons and limpets scrape algae (tiny one-celled plants) from the rock surfaces; tube worms, hinged shelled molluscs and barnacles filter small organisms from the water; and anemones trap food using their stinging tentacles.

Select the best specimens for retention, place two or three animals, with sea lettuce, in each of six jars, barely covered with water (the jars should not be more than one-sixth full) and stow them away out of the sun. Return everything else to the pools. Suitable animals to take home for keeping are smaller anemones, hermit crabs, prawns, tubeworms, half-crabs, cushion stars. The three golden rules are:

1. Very little water. Keep it cool and open to the air.
2. Very few animals.
3. Plenty of damp green seaweed.

After lunch

In a situation where low tide occurs in the late morning the after lunch period could be devoted to either a beach hunt (if there is a sandy beach at hand), an investigation of the sand dunes or

country backing the shore, or some social studies topic connected with the area.

The beach hunt can be developed as a game. Draw several circles each about a yard in diameter in the sand. Send the children to find as much flotsam as possible; standing beside the circles whistle the class back. Take one child's collection and place it in the circles. Put a different type of object in each circle. Then ask the children to sort their finds according to the basis you have laid down. Draw new circles for new types of material. One circle might contain shellfish, one seaweed, one pieces of wood, and so on. Discuss the probable origin of this debris. Note especially the sand hoppers in rotting seaweed. These scavengers keep the beach clean.

Variations of this game will suggest themselves.

In the air

Draw the attention of the children to circling sea birds. These will include shags (large diving duck-like birds with long necks), gulls (small red-billed and large black-backed), terns (with bent wings, forked tails, and black caps), and others which will be readily identified from the texts suggested in the bibliography.

On the way back

Have some children fill their jars with clean salt water and others with water plus clean sand and stones. A jar or two filled with sea lettuce will also be needed. Keep all jars out of the sun on the return journey.

Marram grass, shore convolvulus and yellow lupin will be found on the sand dunes; draw the attention of the children to these plants which help to stabilize the dunes.

At school

Put a layer of sand and stones on the bottom of each dish or plate, add some clean sea-lettuce. Pour in salt water, sufficient to merely cover the animals. As evaporation occurs in succeeding days top up with FRESH water. Place one or two animals only in each plate, making sure that each is perfectly clean. Detail monitors to stir the surface at intervals, for aeration.

For further information see *Teachers' Nature Study Handbook* Chapter 9.

Follow up

Construct a mural showing each animal, its home, its way of self-protection and how and when it feeds. This may be accomplished by setting the children to work in groups, each group investigating one animal, observing it, remembering where it was found, trying to match the animal with illustrations from available books. The results of this work may be recorded either by a group writer or individually, after which the mural may be constructed.

Although making sure that the children themselves carry out most of the follow-up work, the teacher should assist by directing and organising the group work and the reports and by giving a lead with personal enthusiasm.

When the work has been completed (and this should be within a day or two of the field trip) return the animals to the shore or if this is not possible, destroy them.

In conclusion

The approach set out in this article may need to be much modified to suit individual conditions or teachers. It is hoped, however, that the suggestions offered might constitute a guide to action.

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The Sea Shore—Yonge (New Naturalist Series, Collins).
Between the Tides—Philip Street Scientific Book Club.
Post Primary Bulletins—Our Living Environment: Seaweeds, Sand-dune Plants, Coastal Plants.

PART II. EXPLORING THE ROCKY SHORE

P. Devlin

This article is to provide teachers with some of the more immediate objectives and methods which will make a trip to the rocky shore successful. They should be regarded as suggestions only, for it is the initiative of the teacher in organising the trip, in adapting his methods to the particular circumstances and permitting his programmes to vary with the children's responses, that will finally decide whether a seashore trip will be a disorganised ramble, an over-organised excursion, or a time of real exploration.

Objectives: What to Discuss with the Children before We Go

Perhaps a difficult problem with a seashore visit is to decide just what information the children should have before they go.

As a starting point I would recommend the following as topics for discussion:

1. What is the sea? What is sand, and how is it made?
2. What causes tides and ocean currents? Low tides and high tides?
3. Why do you think we find animals in the sea? Do any of them have close relatives on the land? What are some "families" of sea animals?
4. What special adaptations do you think sea dwelling animals would need?

5. What are some of the conditions that they would need to overcome? (Compare with life on land.)
6. Introduce the various groups of animals that are likely to be found, e.g. Fish, crustaceans, molluscs, spiny skinned animals such as the starfish and sea eggs, and the hollow bodied animals like the sea anemones. Are there any others?

Two Essentials: The Interest of the Area and the Interest of the Animals

There is probably no type of area to compare with the shore, both in the variety of animals represented and in the diversity of conditions under which they live. Children can learn an amazing lot at the seashore about animals and their ways of life, provided there is a little preliminary discussion based upon these two headings.

The Area. The inhabitants of rock and sands live a Jekyll and Hyde existence. The falling of the tide ushers in a new world of sunshine and blowing winds very different from the world of salt water, wave and surge. And the animals change their ways of life to match their changed surroundings. Then, we have areas within area—different homes between the tide marks: the high tide zone, the area of mid-tide, and the low tide zone; the bare rock, the crevices, the shaded ledges and the rock pools; all combining forces with the tides and winds to provide a strange assortment of homes for a very bizarre collection of creatures.

The Animals. Diverse and unconventional as the seashore animals are, all alike have to face the common problems of intertidal life—clinging, escape from the hot sun, and feeding. Where wave action is strongest, the rocks are often bare of seaweed, and *foothold* is difficult to obtain. Most seashore animals breathe with gills, and these must be kept moist; so between the tides they have the problems both of avoiding *desiccation* and of breathing. Some do this by retaining water within the shell, some by living in rock pools or crevices. *Feeding* is difficult since the animals are dependent, usually, on the tides for their food; most, therefore, have two meals a day, foraging when the tide comes in.

For the child, eager to see what happens when the tide advances and the seashore comes alive, there is a simple device which teachers may suggest. Lift an animal from its rock home, place it in a pool, and watch to see what happens. If it is already in a pool, but inactive, turn it on its back and watch it right itself. Or place a piece of mussel nearby as food and see what happens.

What to Tell the Children at the Beach

A lot of what you tell the children at the beach will depend on policy and circumstances, but the following general principles could be considered as basic.

1. Dangers of the particular area . . . what areas are out of bounds?
2. When working on the rocks if the sea is at all rough, watch out for big waves. These could be dangerous.
3. Warn children against indiscriminate collecting of animals. Live shellfish should not be collected except by those children who have been given the task of taking animals back to build up an aquarium.
4. There should be no hurrying and everybody should keep as near together as possible.
5. If groups have been organised, send them off gradually to avoid confusion.
6. Even if there are no danger spots at the locality specify definite limits or boundaries so that at all times you will have all the children in sight.
7. Tell the children the present position of the tide.
8. Give a brief explanation of the geography of the area to give the children a better understanding of the environment generally.

Where and How to Look

It is essential that the children know the places where they are most likely to find what they are looking for, and also the best ways to actually look.

There is life to be found, and interesting things to see throughout the tidal zone, so perhaps you could start your explorations, if the tide is still on its way out, at some of the higher rocks at the high tide mark. The highest of these rocks receive only the splash from the waves so it is really quite remarkable that anything can exist there at all. If the tide is on its way in, be sure to start with the low tide zone, and appoint a sentinel to watch for the approach of large waves.

High Up: Look on the under-surface of the rocks . . . look in the crevices . . . look for any other protected areas. Can you find any brown or striped periwinkles? Are there any limpets or barnacles to be found? Look for one of the small permanent pools that are often to be found at this level . . . are there any tube-worms or brown sea anemones there?

Further Down: Further down the tidal zone you will find pools that are permanently left by the receding tide. If there is little or no seaweed in the pool you will not expect to find very much animal life in them. The two—animals and seaweeds, go

hand in hand. The seaweeds provide oxygen to the water and provide essential shelter and shade that is necessary for the animals to survive. Choose then a pool that has plenty of seaweed, is not too deep, and is in a fairly sheltered and shady position.

For a start, approach the pool quietly, and make yourself as inconspicuous as possible. There may be fish in the pool that would be very easily frightened if they see you. If you see them first, however, you will have a golden oportunity to study them at leisure. For a while you will find it best to just wait and watch quietly into the pool. Once you become accustomed to the layout, try to analyse what you see. Note the positions of the seaweeds; the dark corners; the shellfish and the sunny places. After watching for a while you will almost certainly see movement. Those empty looking shells that are lying on the bottom . . . do they gradually lift up? Look for two feelers and then two eyes as the hermit crab makes a preliminary survey. If all is well the head and thorax will appear and with its house on its back the crab will go scuttling along the bottom. Pick one out and watch how rapidly it flicks back into its shell. How does it guard the entrance to its home? . . . What do you think a hermit crab does when it becomes too big for its adopted home?

Can you see any flower like tentacles of the beautiful sea anemones? Watch them as they sway to and fro just like real flowers in the breeze. Touch one and watch how its beauty disappears into a simple blob of coloured jelly. Break open a mussel and drop a small piece into the open tentacles of an anemone . . . What happens? You may even be lucky enough to observe how the tentacles of the anemone quickly grasp any small animal that happens to brush against it.

Find a starfish and watch its sucker like feet gradually draw it over the floor of the pool. Place a small piece of mussel in its path . . . what does it do? . . . Turn it onto its back and watch how it rights itself again.

Look for the tubeworms. First find their white cemented pipe like homes. Can you see their plume like tentacles poking out the front? . . . What do you think they are doing with them? . . . Cast your shadow across them . . . what do they do? . . . Place a finger close to the opening of the tube and watch the reaction of the tentacles as they come out and touch your finger. Do you think they feel or see?

What sorts of shellfish can you see? . . . Are they moving about? . . . If so, how are they moving? . . . What common land animal do you know that moves in the same way? . . . Take one out of the water . . . what is its first reaction? . . . Has it got a hard covering over the entrance to its shell? . . . Look closely at this entrance and see if you can find a canal which leads from the lip of the shell into the shell cavity . . . If it has got this

canal it is a carnivorous animal and will eat flesh. If so, what do you think it would live on? . . . What is there in the pool that would provide food for it?

Can you see any fish swimming about in the pool? . . . If not break up a piece of mussel and drop it in . . . this should attract some form of life. Try to see where the fish come from to get an idea of the type of place that they hide in. What sorts of fish can you recognize? . . . How do they feed? . . . In short nibbles, bite and tear, or do they eat leisurely? How do they move? . . . In quick darts or with a continuous easy movement?

. . . How does their colour help to protect them? . . . When frightened what do they do? . . . Can you see where their hiding places are without moving any seaweed? . . . What do you think these small fish usually feed on?

Part the fronds of seaweed . . . can you see anything new? . . . Are there any snail like shellfish attached to them?

What else can you see in the pool? . . . Are there any clear looking shrimps darting about as if playing chase games?

What to Discuss with the Children on Return

A field trip to the seaside, succeeded by good follow-up work, can provide the basis for a series of interesting lessons and projects.

1. One of the most effective follow-up projects is to reconstruct the seashore environment in the classroom either by model or aquarium. This could be done in groups or with the whole class, and is almost certain to provide opportunity for revision and the introduction of new material.

2. If you have assigned special groups to observe different aspects of the seaside, get the members to make out a written report on what they have discovered. This can be presented to the rest of the class; discussed fully and then all the reports joined together to form a booklet.

3. Other possible projects are . . .

(a) Reconstruction of the seashore environment through models.
(b) Take an art lesson (picture making) of different aspects of the seashore and display them on the wall.
(c) Paint a class mural depicting the whole trip from start to finish.

THE SEASHORE

A Centre of Interest for a Development Approach to Language in Junior Classes

Jeannette Green

During the summer, our junior classes frequently used the seashore as a centre of interest. The beach to many children is a familiar playing ground for swimming and sandcastle building, but to our primer classes the wonder of seashore life is still to be discovered. Through carefully planned excursions with their peer group, the beach can become more than just a swimming place. It opens a new world filled with hiding places which delight the discoverer as he lifts the rocks and reveals the shellfish, sea anemones, and a variety of crabs scuttling away from grabbing hands. Planning a trip away from school, the interest of these finds, new names to find out and remember, never fails to create the interest and purpose for stimulating our language programme.

This is an account of many activities from which teachers selected those which best suited their classroom situation and level of understanding and experience of their ability group.

Introducing the Beach Topic—Suggestions for Preparation

Careful planning and preparation are essentials both of field work and of a centre of interest in the classroom.

Teacher and Parent Co-operation

Teachers might send a note to parents requesting bus fares, suitable clothing (plastic sandals prevent slipping and cut feet), for mothers to help on the trip and permission for the child to go.

When to go to the Beach

Consult the tide timetables and select a time when the tide is out. Low tide is the best time for rock pool hunting.

Introduction to the Class

Interest in the beach might be stimulated through: —

(1) Beach pictures and stories of the Seashore.

1 See Discovery magazine, October, 1963, "Man Against the Sea," by Stanley Miles.

(2) Beach Film strips. There are no film strips for junior classes on the Beach topic, but "The Rocky Shore" (56/141) can be successfully used if the captions are disregarded.

(3) Let's Visit the Beach. The teachers and the class might begin planning this several days before the visit. What will we take with us? What will be do at the beach? How will we get to the beach and most important—What will we find? and where will we look?

Sometimes young children, if they have not discussed these questions, imagine they will catch enormous fish, and are disappointed by their finds.

The idea of smallness and of looking carefully, needs to be introduced. I once told a group of primers that I knew there were hundreds of animals down at the beach near the school, and I asked if anyone had seen them. They looked at me with disbelief, but I insisted, and we began to think where they might be. We decided that they must be hiding, and discussed digging up the mud, turning over the rocks, looking into cracks and under ledges, and so together we worked out where we would do our hunting.

Begin a Beach Finds Section on the Nature Table

Children might bring shells they have at home to begin with.

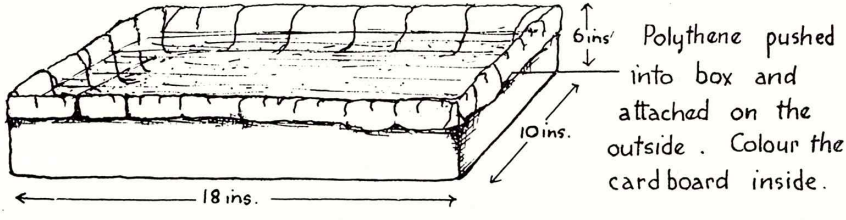
Collecting Equipment

Teacher's equipment—First aid kit, whistle, large jars for salt water.

Children's equipment—Plastic buckets and spades and plastic bags for sand and rocks.

Make Homes for the Seashore Animals to Live in at School

Each table or group could make one of these simple carton aquaria during activity time.



So that the animals can be easily seen, paint the inside of the box with a light colour before putting polythene inside. Fasten the polythene down with paper clips or cellotape around the top on the outside. Children may cover the outside of the box with paper and decorate it suitably.

Activities on the Beach

1. Let the children play on the sand, build castles, feel and experience the sand. This is as much a part of the beach as the animal hunting is to small children and should not be disregarded on a school visit.

2. Collect empty shells along the high tide line, drift wood, birds' feathers and dried up seaweeds.

3. Rock pool hunting.

4. Digging in the sand and mud in the mid and low tide zone. Children may find whelks in groups feeding, small crabs in holes in the mud, pipis, cockles and tuatuas buried in the sand.

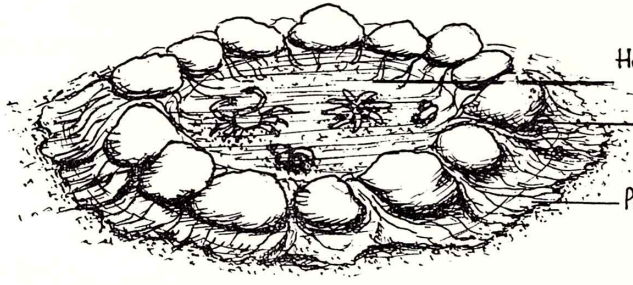
5. Finding games in the sand. "Run and find me an empty brown shell, a sandhopper, a seagull's feather"; or "Find me a shell like the one I have here."

6. Quiet time and some relaxed thinking.

The music of the seashore is not even heard by so many children until their attention is drawn to it. Ask the children to lie flat on their backs and listen to the sounds of the waves, the wind, the seagulls calling for food and the other sounds for 3 or 4 minutes.

7. Feeding the seagulls.—Take some bread scraps to attract the bird life on the shore. Quietly watch the gulls flying in and taking off again, gliding in the wind, and watch their feet tucking up under their body like the wheels of an aeroplane as they alight from the ground. Find their footprints in the sand.

8. Make a rock pool at the beach.—Dig a hole in the sand and push into this a large square of polythene. Hold the sides down with sand castles or rocks. All the children's finds can be put into this with sea water and then only the best selected to take back to school. Each group might make one, and then select the animals for a group aquarium at school. This practice helps to conserve life on the seashore, where many classes may be removing material from the same beach. It also avoids the inexcusable jars of dead animals smelling in classrooms which invariably happens when children remove from the beach more than can be cared for in aquaria at school.



[After Mr J. Dagger
Agricultural Instructor
Auckland]

9. Observation of surroundings.—Looking at the opposite shore —boats in the harbour, trees on the beach.

10. An activity for upper primers.—Mark the level of the tide by driving a stick into the mud when you first arrive at the beach and later in the day when the tide is out, measure the distance it has fallen.

11. For further information on activities at the beach.—Refer to the Nature Study Bulletin: articles on "The Rocky Shore" (February, 1958), "The Sandy Shore" (May, 1958), "The Mud Flats" (September, 1958).

Back at School

1. Set up the aquaria in the boxes that the children made.
   (a) Wash sand in fresh water and scrub the rocks to make sure all animals not visible, which might make the aquaria smell, are washed away.
   (b) Fill aquaria with salt water from the beach, and mark the level. Do not make the water too deep.
   (c) Do not overcrowd the box. Not more than **six** animals. Crabs, sea anemones, small starfish.
   (d) Keep aquaria away from hot sun.
   (e) Feeding. Do not feed until 4 or 5 days after setting up. Small pieces of meat or fish tied to a piece of cotton will be sufficient. Remove what is left after 3 or 4 hours.
   (f) Box may be tilted by children to bring the tide in and out.
   (g) *Aeration.*—A bubbler may be set up (see Nature Study Handbook by Beggs), or daily the children may take out a cup full of the water from the aquaria and pour it back from a height.
   (h) *Water Level.*—Replace the salt water as it evaporates with water from the tap, keeping the water level maintained at the original mark.

Things to Make and Write

The experience has encompassed a great variety of material, and each day a new aspect of the trip might be investigated. Some of the topics might be general impressions of our trip: How we went to the beach — Crab hunting — What we found under the rocks — Sandcastle building — The Seagulls. Observations in the aquaria will be continued daily, and the children will be able to find out more about these particular animals, which will form the basis of some of their activities.

Seashore Murals.—Using collage materials, particularly sand pasted on to the mural.

Lift the Stone and Look Under.—Refer Nature Study Bulletin 1960: Lift the Stone and Look Under—by Doreen Brady.

A Model Rock Pool.—"We attempt to make the pools we saw at the Beach." Use a large cardboard box. Children make fish in cardboard and colour in mosaic patterns, with gummed paper on the back. Rocks can be made with newspaper and paste, seaweeds from china packing. Plasticene and pipe cleaners for starfish and crabs. Springs can be suspended across the box top and fish suspended on string to make them swim.

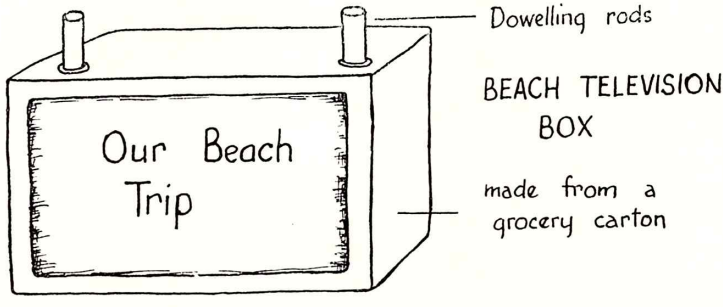
Stuffed Paper-fish and Crabs.

Observations of crabs in the aquaria, counting of legs, feeling of hard shell, looking at the colour pattern on the crab's back, might be followed by this craft:—

Children outline animal on large sheets of newspaper and out of two of these shapes, paste one, and cover with torn strips of newspaper. Cover with the other outline. Staple around the edge or stitch (needlecraft). Add legs and paint.

Make a Beach Scrapbook. Children may find beach pictures at home. These can be pasted at school into the scrapbook and a caption either dictated and written by the teacher or written by the child and put beside it.

Beach Television Box



Film is made from children's paintings and writing, and put into the box for screening and reading by the children.

Experience Vocabulary. New words connected with the beach will be found as each aspect is explored.

On the Nature Table—"Shell of the Day". Each day learn the name of a new shell. Talk about it, its colours, listen for wave sounds in the univalves.

Seashore songs and poems.

Musical Appreciation.—Listening to music that reminds us of the sea—creative movement, fish swimming and seaweed waving.

Review. The results of this work lead those of us who worked on it to believe that it served a twofold purpose. Firstly, it was a real nature study situation. Out of doors, in natural conditions, the children began their investigations which were then continued back at school in their aquaria.

Observations and the experience led us to hours of purposeful activity embracing a wide range of expression.

A programme for children on these lines brings about a desirable compromise between understanding (of the world in which they live) and accumulating skills (those needed for this understanding).

Terrestrial Communities

* THE GRASSLAND — MAINLY INSECTS

A Topic for Summer Months

Roger T. Murdoch

HOW TO EXPLORE THE GRASSLAND

Most would agree that in this country, which is essentially a rural one, the grassland is the most common nature study habitat handy to schools. It matters not whether the "grassland" is cultivated pasture, native grassland, or just an unmown corner of a park. Each abounds in an insect life as strange and as interesting as any.

Thus, a grassland insect study is justified; but how many teachers are "prohibited" from doing one because of their so-called lack of knowledge or because they lack the realisation that it would be very worth-while? The aims of this article are to give you confidence in taking *your* class to such an area and to show just how worthwhile it could be.

Where to Look

"But there is nothing of any interest to see in a piece of grassy land." How wrong this is. In planning an insect study with your class, it is as well to zone the area to give you a better understanding of the characteristic insect types within each, their modes of life, and their adaptation. We could zone it as follows:

1. *In the Soil*: Insects on the way to adulthood pass through remarkable transformations. Each stage requires its own special conditions, and the grassland, zoned into areas of light and shade, provides these. In this zone we find the temporary inhabitants, one phase in the life cycle, to whom the earth is a nursery of even temperature and denser texture, mothering and protecting them through this phase of helplessness. Their skin colour does not matter. Many are simply white, which although it contrasts with the "black" earth, does not betray them in their concealment.

Most forms feed on plant roots and do not have to come to the surface until the next stage in their metamorphosis.

Most of the insects in this zone will not be dealt with as they are the subject of a further article.

2. *On the Soil and Lower Stems*: This separate zone is one of adults. The environment allows for hiding and provides food for these insects, which fly little or not at all. They are generally fleet of foot in order to dart under cover and their colouring is dark to match this cover. Mature forms deposit their eggs in the soil near the surface where the warmth from decaying organic matter incubates them.

3. *On the Grass*: This is the territory of flying or jumping insects, camouflaged at rest and conspicuous in movement. Camou-

* Refer also to The Farm.

flage is most important to them as the conspicuous movement, for mating purposes, must be abated when predators come on the scene—the insect then relies on "toning in" with the background.

4. *On the Shrubs and Flowers*: The shrubs of the grassland provide a different cover still and carry larval forms of many insects. Here and there flowers provide nectar for those which like it.

Thus the grassland acts in two main capacities—it is a nursery and it is a host to insects. The nursery provides vast insect populations for opportunists who select their prey at will (spiders, parasites) and for honest predators (birds).

What to Look For

We shall take the most conspicuous members of the community first:

Butterflies of Pasture and Tussock

These are the few which are conspicuous in flight to attract their mates, but fly in a zig-zag fashion for dodging enemies. When chased, after a brief flight, they suddenly alight on some object and become "invisible" due to the inconspicuousness at rest. This is brought about by the resembling colouration on the lower wing surface, which alone is showing at rest, while the upper wing surface is richly coloured.

Butterflies frequent the upper zone of flower and shrub. The adults are nectar feeders and the larval stages are nursed by these shrubs for which they are specially camouflaged.

1. *Tussock Ringlet* (Argyrophenga antipodum)

This butterfly is restricted to the South Island tussock lands, being most common from Christchurch southwards.

When and Where to Look:

Between mid-November and the end of March, look for it flying aimlessly among the tussock, but to see it at rest requires very good observation. It hangs from a leaf, displaying only the well camouflaged under surface of its wings.

Life Cycle:

The bright greenish larva with yellow lines on the sides and on top, is 1 inch long when fully grown. The colour thus protects it on its host plant, Silver Tussock, as these yellow lines imitate the blades. The pupa is suspended by its tail from an upright stem and is also bright green with a brown line down the wing case. It is $\frac{3}{4}$ inch long. The adult emerges in mid-November.

References:

Nature Study Bulletin Vol. IV No. 2—"Some of Our Smaller Butterflies".

New Zealand Moths and Butterflies—G. V. Hudson.

2. *Common Copper* (Chrysophanus salustius)

The Common Copper butterfly is fairly generally spread over both Islands and is said to be New Zealand's commonest butterfly.

When and Where to Look for it:

From October onwards, but more commonly from January until April, it will be seen in open tussock country and is most abundant among low scrub. It lays its eggs on the underside of the Pohuehues (Muhlenbeckia species) where the adult is said to be protected against the light under-leaf surface colour of many bushes by the dull yellow side of the wings exposed when at rest.

Life Cycle:

The pale blue-green eggs are laid singly and turn yellow before hatching. Somewhat resembling the common slater, the larva is bright green with a crimson line down the back after the first moult. This is the overwintering stage and after another feeding period in spring, it reaches the fully grown size of $\frac{5}{8}$ inch by the end of October. It pupates under dead leaves on the ground. The pupa is $\frac{3}{8}$ inch long and pale yellow in colour with a brownish front end. The adult emerges about the first week of November.

References:

Nature Study Bulletin Vol. IV No. 2—"Some of Our Smaller Butterflies".

New Zealand Nature Study—W. Martin.

New Zealand Moths and Butterflies—G. V. Hudson.

3. *Little Blue* (Lycaena labradus labradus)

This butterfly is moth-like in one respect—its upper wing surfaces are not conspicuously coloured as is common to most butterflies. Thus, in flight, it is harder to sight and the under wing surfaces are still protectively coloured to a high degree, which makes it almost invisible at rest.

When and Where to Find It:

In the north, the Little Blue is to be found in nearly all grassland locations and is a common visitor to gardens and parks. It is common in localities with a warm, dry climate and is rare in the extreme south. It may be seen from October until late March.

Nothing has been published on the life cycle and so apparently it is unknown. There may be a reader who can help.

4. *Casual Visitors*

The White Butterfly; Red Admiral; and Yellow Admiral are among these. They visit the upper zone of the grassland where flowers are sought out for their nectar.

For more information about these and butterflies in general refer to:

Nature Study Handbook—D. Beggs.

New Zealand Nature Study—W. Martin.

Garden Pests in New Zealand—D. Miller (White Butterfly)

Moths of Pasture and Tussock

The grassland moths are a large family of small species. They are mainly nocturnal by habit, but many may be seen flying away when disturbed in the daytime. Differing from the only partially camouflaged butterflies, the grass moths are totally camouflaged on both wing surfaces. They rest with wings held tentwise, exposing the upper surface, and many fold their wings as if wrapped around the body. As their adult stage is more common in late summer with browned grass and tussock, the majority of colour combinations are made up with various shades of light brown.

1. *Crambus Moths* (Crambus species).

Most of the 45 species known in New Zealand are found in the South Island. They are characterised by fore-wings which wrap tightly around the body at rest, completely enveloping the hind wings. Resting vertically on a blade of tussock, they resemble their host so exactly that you will find them hard to see. White stripes down the fore-wings also aid this perfect camouflage. However, crambus moths are easily seen and tracked in flight.

A common species, Crambus vitellus, has a conspicuous broad, white stripe on the dull brown fore-wings.

Reference:

The Moths and Butterflies of New Zealand—G. V. Hudson.

2. *The Porinas* (Oxycanus species)

The adult non-feeding moths are perhaps less well known than the larva. The latter are the common grass caterpillars which, together with grassgrubs, cause so much damage to New Zealand's pastures.

Where to Look:

To find the larvae, look for castings on the ground surface resembling those of the earthworm but mixed with silk. The adults will be seen in flight after hot days or about lights at night.

Life Cycle:

Most of the moths lay their eggs in October. They hatch in 3 to 5 weeks. The larvae live in tunnels but come out to feed on plants above ground level. This goes on until the following September and October when they pupate until the next flight season.

The small oval eggs when laid are creamy-white but within a few hours most of them turn jet black.

References:

Department of Agriculture Bulletin No. 244—"Grassgrub and Grass Caterpillar Control".

Garden Pests in New Zealand—D. Miller.

Hoppers of Pasture and Tussock

Flying above the grass, on the gress stems, but mainly in the lower zone of stem bases at ground level, the hopping insects may be found. This group, representing the straight-winged insects, are regarded as rather primitive, but when we see their devices for escaping danger it makes us wonder. They all have very muscular hind legs for escaping their predators (namely birds), by jumping to safety. However, if they are seized by a limb, a further safety device is brought into play—the leg is shed like a lizard's tail and in many cases it is later regenerated.

Some have the power of flight, which, although clumsy, is generally strong. Many of these Straight-winged Insects have no wings, or just mere traces in the form of wing buds.

Protective colouration is remarkable in the hoppers. As with the Scale-winged Insects (moths and butterflies) and, as we shall see in the insect groups which follow, this camouflaging is all-important to any insect community. Most insects are helpless without it. If, when watching a member of this group, you miss for a moment the location or the mating serenade, you may find it well-nigh impossible to locate again, although it may be only a yard away, and fully exposed.

A. The Earthlovers

These enjoy basking in the sun on bare earth but when danger threatens or the weather is not fine, they retreat into the crowns of grass or cracks in the earth. Generally they are darkly coloured.

1. *Australian Field Cricket* (Gryllus servillei)

This $1\frac{1}{4}$ inch long cricket is well known for its continuous chirping on late summer evenings and often through the day. This chirping is not unlike that of a canary. In the past, serious outbreaks have occurred in which pastures were practically defoliated.

It is distributed over the North Island and the northern part of the South Island.

When and Where to look for Them:

In the summer months trace the characteristic chirping, and keen observation will be rewarded by seeing the darkly coloured insect move under cover. From then observation is easy if you keep your eyes "glued" to your subjects. Although they have long hind legs, they seem to walk and scurry more often than they hop. They rarely if ever fly.

Life Cycle:

After overwintering in the egg stage, the nymph hatches and after a series of moults reaches maturity in summer. This three-stage life cycle, typical to the group, is different from that of the Scale-winged Insects (and others) in that it omits the larval stage so characteristic of them. The female of the species is easily recognised by her long ovipositor which she uses to deposit her eggs well below the ground surface.

References:

Nature Study Handbook—D. Beggs.
Department of Agriculture Bulletin No. 326—G. L. Banfield.

2. *Native Cricket*

A smaller cricket with a quieter and higher pitched chirp, it has a body no more than $\frac{1}{4}$ inch long. It is common in the south.

Where to Look:

The Native Cricket cannot be traced easily from its voice but close observation around the base of grasses reveals it without difficulty. Although very similar in habits to its larger brother, it appears to jump more when danger threatens.

The life history is similar to that of the Large Field Cricket.

Reference:

Nature Study Handbook—D. Beggs.

3. *Short-horned Grasshopper* (Phaulacridium marginale)

It is said that the females never have wings and only about 1% of the males are fully winged. The females are generally slightly larger but their length does not exceed about $\frac{1}{2}$ inch. In keeping with the general dark colour of earthlovers, this grasshopper is in shades of dark brown.

Where to Look:

Look on bare patches of earth and around the grass bases. It will be seen that these insects are more active than the crickets, having a powerful jump which makes them harder to catch.

Life Cycle:

Eggs are laid in the ground and in spring, growth is once again through a nymph stage.

References:

Nature Study Handbook—D. Beggs.
Insects of Australia and New Zealand—Tillyard.

B. The Grasslovers

These members frequent the zone of grass stems and blades, displaying highly organised adaptive colouration.

1. *Migratory Locust* (Locusta migratoroides)

To clear up a common misapprehension, locusts, strictly speaking, are all the short-horned grasshoppers. Rarely, however, is more than the one species described as a locust in New Zealand. One of the plague locusts of other countries, it is distributed over the North Island and the northern South Island. There are two phases of this insect: a gregarious phase which swarms giving plagues; and a solitary phase which does not swarm. Fortunately, New Zealand has only the latter. This is rather surprising as locusts are voracious eaters of grass, and the greater area of this country is in grassland. However, the climatic factor would govern this.

Where to Look for Them:

Sunny hillsides are the best places. These are the insects which, when you disturb them, rise in a clattering flight 15 - 20 yards from you and look for all the world like small birds. Flight is swift to a further resting place 50 - 70 yards away, and unless the exact alighting place has been carefully noted, you will have little chance of finding your specimen.

Life Cycle:

In spring, eggs of the locust hatch into miniature replicas of their parents, but without wings and with a shorter body and legs. During a series of 5 or 6 moults, wing buds appear and lengthen, legs strengthen and lengthen, and the whole body becomes longer. From the last moult in summer emerges the adult.

Yellow, $\frac{1}{4}$ inch long, cigar-shaped eggs are laid singly below ground level—a hole is made by the long abdomen—and the insect overwinters in this stage. On dissection, two females yielded 54 and 84 eggs respectively—the larger number came from one presumed to be holding her full capacity.

References:

Australian Insects.

Insects of Australia and New Zealand—Tillyard.

2. *Long Feelered Grasshopper* (Xiphidium semivittatium)

This is a very insignificant insect in the south but common in the north. The only two I have found were seen on a butterfly net which was lying on the ground. You may find it worthwhile to spread a piece of white linen on the ground and disturb the surrounding grass. If luck is with you, your quarry will appear on the material. The green grasshopper with two yellow stripes down its back, resembling blades of grass, provides a good lesson in camouflage.

Made up of two sword-like sheaths, the long ovipositor of the female suggests that she is fussy about the welfare of her eggs and deposits them in the ground.

The wings are well developed and the hind legs are very long.

C. The Shrublovers

Katydid or Bush Cricket (Caedicia simplex)

The Katydid is found from Nelson and Marlborough northwards.

Where to Look:

This cricket belongs to the upper zone in our early zonation, living in low shrubs where it is perfectly camouflaged. Its green fore-wings are shaped and veined like a leaf. The subdued chirping of the male is heard at night.

Life Cycle:

The oval eggs are laid in stems and the margins of leaves. Again the life history is a typical three-stage one of straight-winged insects.

References:

Native Insects—David Miller.

Nature Study Handbook—D. Beggs.

Parasites of Pasture and Tussock

In your searches, you may see many small, four winged, somewhat wasp like insects with a very narrow waist and often very handsomely coloured. These will be representatives of the large group of Ichneumon Wasps (sometimes falsely called flies). They are all parasites of insect larvae. The female Ichneumon wasp punctures the skin of a larva with her ovipositor, and places her eggs within the hapless creature.

A well-known species is the larval parasite of the White Butterfly introduced to control that pest. It is commonly seen in the pupal state as small yellow cocoons clustered around a dead caterpillar on a cabbage leaf.

Small Black Ichneumon (Echthromorpha intricatoria)

The head, thorax and abdomen of this insect are a shining black while the abdomen has white spots up either side. The legs are bright orange and the transparent wings have dark markings. This is a parasite of the Red Admiral Butterfly.

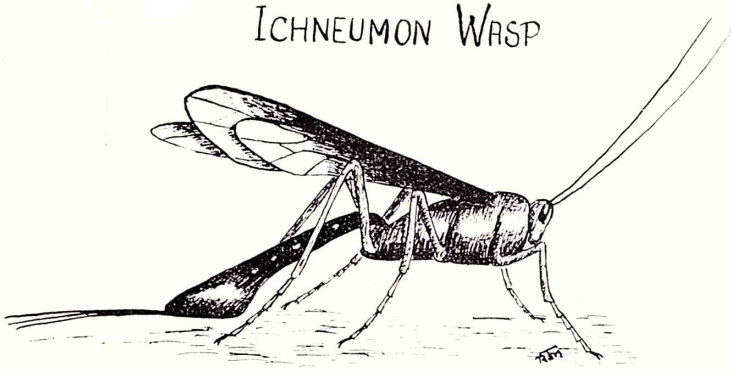
Many ichneumons parasitise wood boring grubs, penetrating the wood until the soft body of its victim is found. One of these, the largest native species, is the Giant Rhyssa (Rhyssa fractinervis). Some of these may be found as casual visitors to our grassland community.

References:

Native Insects—D. Miller.

Garden Pests in New Zealand—D. Miller (brief mention).

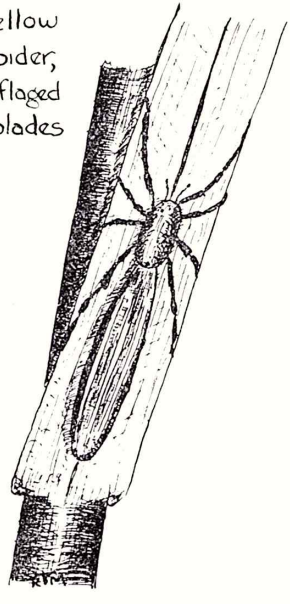
Ichneumon Wasp

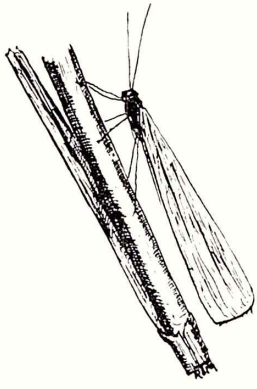


A member of a large family of parasites

An Inconspicuous Spider
(Argiope pratensa)

A green, yellow striped spider, well camouflaged on grass blades





A Crambus Moth

Its method of wrapped wings at rest, as well as its colour, protects it.

Other Than Insects—
Spiders of Pasture and Tussock

Spiders differ from insects in that the head and thorax are fused (to form the cephalothorax), forming together with the abdomen, a body of two parts. They have eight legs. In our community, they will be found commonly in the upper zone of shrubs but also on the taller grasses and tussocks, and in many cases on the ground. They are all, throughout life, killers and eaters of other living creatures.

1. *Orb Weavers*:

With its large abdomen, the orb-web spider seems to be out of proportion in this region. Many have a triangular shaped abdomen, with the broad part forward, and most belong to the same genus *Aranea*. One species (Aranea viridata), has a green leaf-shaped marking on its back—the need for this is obviously to protect it from predators (e.g. birds). So this predator has predators of its own. This marking also gives a clue to the spider's specific habitat (on shrubs).

Others have long, cylindrical abdomens. One such species (Argiope pratensa) shows a green striped abdomen (resembling blades of grass) to protect it mainly from the Mason Wasp which catches and stores the spider in small clay compartments with which an egg is laid. When the young wasps hatch they have a ready food supply.

Where to Look:

The geometric webs of this group are well known. Look for them in shrubs and on the tall grass. Some orb-web spiders you will find, wait in the centre of the web for hapless victims, while others will be seen to hide nearby.

Life Cycle:

The life span is generally about one year. From the tiny webs (of youngsters) in Spring there is a gradual increase in size until, in Autumn, we find the large webs of mature spiders. Eggs, placed in a spherical silken cocoon, are the overwintering stage. Often, after mating, the male is killed and eaten by his partner; but now egg laying has proven too much for the female and she dies also.

After winter, spiderlings are distributed by the wind on threads of silk ("gossamer").

References:

The Spider—John Crompton (web spinning).
Nature Study Bulletin Vol. VI No. 3—"The Gorse Patch".
Nature Study Handbook—D. Beggs.

2. *Sheet-Web Spiders*:

The webs of these spiders have little symmetry and are often on a horizontal plane. Insects taking off and landing on the grass or shrubs are thus captured.

Where to Look:

Look for the webs in shrubs, grass or tussock and even among clods at ground level.

3. *Funnel-Web Spiders*:

Stretched across grass or shrubs, the web consists of a sheet of silk which narrows into a funnel where the spider lurks. Here it is close at hand to seize its victims.

Reference (Funnel and Sheet-web Spiders):

Nature Study Handbook—D. Beggs.

4. *Leaping Spiders*:

Relying on their keen eyesight, leaping spiders hunt insects from a lair and stalk them with a series of short rushes ending in a leap of capture. From behind its abdomen it trails a single thread of silk, the tension of which catapults the spider back to safety within the hideout.

References:

Nature Study Bulletin Vol. VI No. 3—"The Gorse Patch".
Nature Study Handbook—D. Beggs.
Native Animals of New Zealand—A. Powell.

5. *The Nursery Spider* (Dolomedes minor).

The white silken tents of the Nursery Spider are also well known. Closely related to the Water Spider, it also likes damp situations where it finds the type of food it prefers.

Where to Look:

Look for "tents" on the shrubs and tall plants of the grassland. The long seed heads of a dock often supports one.

Life Cycle:

In summer the female, carrying her egg sac, places it on a shoot and spins the nursery around it. This is later broken by the growing shoot and the spiderlings are liberated. Silken threads are spun as escape bridges by them.

References:

Nature Study Bulletin Vol. VI No. 3—"The Gorse Patch".
Nature Study Handbook—D. Beggs.
Native Animals of New Zealand—A. Powell.

6. *Trap-Door Spider* (Arbanitis gilliesii):

This South Island spider is one of the group of tunnellers. It is large and hairy with powerful fangs that work up and down instead of sideways as in other spiders. In its tunnel it awaits unwary passers-by who may provide it with a meal.

Where to Look:

Look on banks and tussock land for a cleverly concealed lid made of silk, but camouflaged, which leads into a tunnel about $\frac{1}{2}$ to $\frac{3}{4}$ inch in diameter.

Other tunnellers may be found in both Islands but their tunnels lack the lid.

References:

Nature Study Handbook—D. Beggs.
Native Animals of New Zealand—A. Powell.

How To Look

When? That this is essentially a summer study should be remembered. At the end of the year but better still in February, March, and April would be the most suitable times. At other times only a small percentage of the total insect population is available for easy study—as seen in the last section, most forms overwinter in the less interesting egg or resting stage.

Where? Various factors decide the suitability of a piece of grassland for a class study:

A To facilitate study—

1. The area must be reasonably handy to give it full justification. You will make many trips to it.

2. It should be easily accessible. This does not eliminate a special field trip to study some tussock hillslope but means that the main study requires a piece of land where many trips can be made within the minimum of time loss in gaining access to it.

B Places that insects like—

3. Insects like warmth and sunshine. A sunny hillslope (facing north and west) is ideal but any sunny area is good.

4. Shelter is also needed for hiding and for warmth.

5. Insects and spiders need moisture.

6. A minor factor but one worthwhile considering, is the age of the grassland. Virgin land or an old pasture is better than a new one which has recently been ploughed.

Conditions under "B" are generalisations. For instance, exceptions are the moths described which are nocturnal and do not like sunlight.

Some teachers may do comparative studies of different habitats within the grassland which are a great aid in understanding adaptations.

Equipment

It is suggested that the minimum equipment needed is enthusiasm and a good pair of eyes. These two assets are by far the most important in your class. To "feed" this enthusiasm and to encourage closer observation however, insect collecting gear, catching nets and a working nature table will assist greatly.

You will find fathers in most cases will gladly construct butterfly nets for an enthusiastic son or daughter. Preserving jars with a muslin top and containing a miniature reconstructed habitat make good insect homes. Also, match boxes with a cellophane top are good for collecting.

Some Hints for Looking

As the moths and butterflies rise at your feet, track them to their nesting place. They are so hard to see at rest that this method is necessary. Followed by a stroke of a butterfly net, it is the only way to catch the Migratory Locust. Some hoppers may be tracked by the ear (Crickets) and others simply by the eye (Grasshoppers).

The parasitic ichneumon wasps will not be overlooked in their conspicuousness above the grass tops.

Present in nearly all grassland areas, orb webs, showing off their architectural beauty, are best seen on dewy mornings. If the orb-web spider is not waiting in the hub of the wheel, then she will be on a nearby twig. A hungry spider will be brought out of her concealment by placing a vibrating tuning fork against the web. See how many times you can fool her.

A Grassland in the Classroom

For ideas on setting up your Nature Table see "Your Nature Table". Insects other than the Straight-winged can be successfully treated in the same way. You will find considerable need for reconstructing a grassland habitat in order to give completeness to your study. Children are collectors and moreover, they like to be able to study insects closely. Your pupils will enjoy watching the insects from "our grassland community". They hold so much interest.

Bibliography

The Moths and Butterflies of New Zealand—G. V. Hudson.
Garden Pests in New Zealand—D. Miller.
Insects of Australia and New Zealand—Tillyard.
An Elementary Manual of N.Z. Entomology—G. V. Hudson.
Native Insects—D. Miller.
Native Animals of New Zealand—A. Powell.
Nature Study Handbook—D. Beggs.
New Zealand Nature Study—W. Martin.
Nature Study Bulletin Vol. VI No. 3—A. Morgan.
Nature Study Bulletin Vol. IV No. 2—D. Hunkin.
Department of Agriculture Bulletin No. 244.
Department of Agriculture Bulletin No. 236.

STRAIGHT-WINGED INSECTS OF GARDEN AND PASTURE

R. T. Murdoch

How many straight-winged insects (order Orthoptera) have you near your school? You can probably find some of these: praying mantis; katydid; a weta; cockroach; a stick insect; native cricket; Australian field cricket; mountain grasshopper; long-feelered grasshopper; short-horned grasshopper; or a migratory locust. Perhaps we could include the earwig in this list as a close relative. Why not use this group as a theme for a fortnight and challenge your class with—"How many can we find?"

To Start With

Perhaps have an all-class hunt in the school garden and adjacent grassland to give the idea of how to look and what to look for. From here they can search at home.

How to go about the Study

Have the children find some straight winged insects and bring them to school. Observe them separately on the Nature Table or by Team Discovery (group observation). Then discuss what they have in common, why they make a family group. Finally have a family gathering on the table as a resumé of what we have found out.

On Your Table

Display each insect in a preserving jar (with perforated top) containing some of the original habitat as it is brought along. The accompanying card, the main function of which is to guide observation, could read as follows:

Australian Field Cricket

This pest of many farming areas was first introduced from Australia.

Observe:—

1. The dark colour for camouflage against the earth.
2. The large ovipositor of the females.

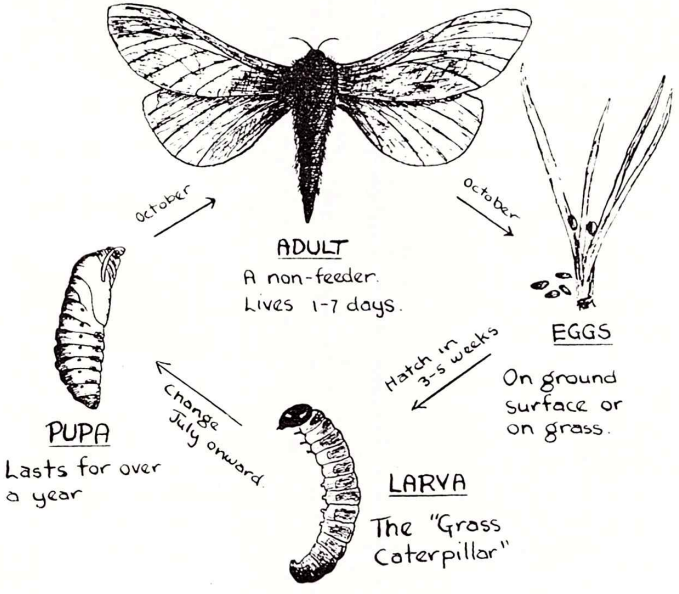
Questions:—

1. What are two ways by which it protects itself?
2. Can you see any special projections on the hind legs? What may these be for?
3. Would the eyes be of particular importance to it? Give reasons for your answer.
4. Is the fore-wing vein pattern of the male and female the same? Draw them.

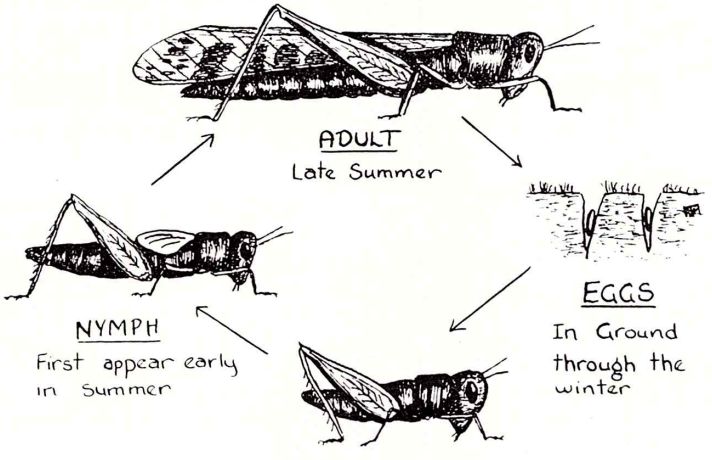
Something to do:—

Find out if both the male and female sing, and describe how the sound is produced.

Porina Moth – A 4 Stage Life Cycle



Migratory Locust – A 3 Stage Life Cycle



Finally, reconstruct a pasture habitat with sods of grass growing in a large, shallow tray and, alongside, a garden habitat with pieces of shrub in containers. Two cards could describe the conditions prevalent in each habitat. Your general table heading could list the factors that the class has decided upon as being common to the group. It may read as follows:

Straight-winged Insects:

1. Have straight, leathery fore wings. These form a cover for the hind pair of flying wings.
2. Have poor flight, where any. Many have lost this power.
3. Have a mouth for chewing.
4. Have a three-stage life cycle, i.e., egg—nymph—adult.

It is quite important that the children should finish the theme understanding that Straight-winged insects are only one group of the vast insect population.

Books for the Table

Native Animals of New Zealand—A. W. B. Powell.

Native Insects—David Miller.

New Zealand Nature Study—Wm. Martin.

Nature Study Handbook—D. Beggs.

Department of Agriculture Bulletin. No. 326 — Banfield. (Control of Crickets).

THE LAWN OR PLAYING FIELD

B. McDonell

An Unexplored Jungle

What is a lawn or playing field? How can these areas be used for Nature Study work? We sit on them, walk across them, gaze at them, mow them, and of course play games on them, but how much do we really know about the school lawn or playing field? These areas are unexplored jungles teeming with plant and animal life. They can be used for a worthwhile unit of observational work.

Introducing the Unit

To introduce the unit a quick comparison can be made with the adjacent asphalt. The lawn has an inviting, hospitable, fresh look; it is teeming with life if you care to look closely at it; high fertility, and fairly constant temperatures, together with the property of being able to hold water, are further deciding factors. On the other hand, the asphalt is bleak and uninviting to the naturalist; desert conditions prevail, sudden changes of temperature are frequent and moisture runs off quickly. What a contrast between two areas that are side by side. It is natural that we turn to the lawn because of the interest that it holds for us.

What is needed for our Study

Discuss with your class what is needed for our study of the lawn. What are we likely to find? How are we going to keep these plants and animals? For example, jars for insects and small animals, plastic bags to collect plants, stakes and wire netting (for quadrat). If not already in the playground a moveable bird table could be erected to one side of the area under study, to attract birds. Set up a tray for a model lawn inside.

How do plants and animals get their food?

Like us, plants and animals need food to live and develop. How do they get this food? It should be made clear to your class that animals depend on plants for their food.

The Earth Science Section of this Bulletin will help to explain this.

A clear way of summing up the explanation is to make a simplified carbon cycle or a Food Cycle diagram.

Animal and Plant Communities

The lawn can be broadly divided into two communities, plant and animal.

THE ANIMALS

(i) Insects on Plants

In this group we can find bees, spiders, tiny plant hoppers, especially in long grass, spiders, ants and wasps. Are special insects found on particular plants? Can you give any reasons why they are there? e.g. bee pollinating white clover. Of special interest in this section is the small gall wasp (Aulax hypochaeridis) that hatches from a gall on the cat's ear weed (Hypochaeris radicata).

The Cat's Ear Gall

The Cat's Ear gall is an unmistakable swelling in the stem of catsear. The female adult wasp (about 1.2 m.m. in length) pierces the stem surface and lays its eggs in the resulting scar. The presence of the egg causes the plant to grow around it, thus forming the swelling which protects the developing egg. Some birds know how to split open the gall and eat its inhabitant. What birds do this? Place some Cat's Ear gall in a suitable container and watch them hatch. How many wasps hatch from each gall? Can the young wasps fly immediately after hatching? How long do they live for? Such observational questions can retain the children's interest in what appears to be "just another disease".

(ii) Insects and Animals in the Ground

The earthworm is an obvious example of an animal living in the ground. To make a closer study a wormery can be set up on the Nature Table. Two examples of these are given in Nature Study

Handbook for Teachers. The earthworm tunnels can be clearly seen after removing the black paper from the sides of the wormery. Natural observations can be made by setting up a transect.

The Quadrat

This entails setting aside a section of the lawn, about 3ft x 3ft, by marking with pegs and covering with wire netting to keep birds and small animals away. The quadrat should preferably be set up in a little used part of the lawn. Within this quadrat the plants and animals can be noted on a plan, map or similar recording device. Worms can be counted by vibrating a peg driven into the ground or sprinkling the ground with a mixture of Condys crystals and water, after which the worms will come to the surface. For additional information and method, see Nature Study Handbook, and the September 1959 Bulletin.

A Town Underneath the Ground

Many types of beetle larvae are found in the soil. These, with the earthworm, are the inhabitants of a sort of underground town, of interest to children. The dirty cream coloured larva of the Chafer Beetle (Odontria zealandica), or grass grub, is present in many areas. The grass grub feeds on the roots of grasses and other plants found in the lawn. (It will even eat carrots in the vegetable garden!) and has become really troublesome in some areas. They can, when present in large numbers, destroy a paddock in a few days. The grass grub is often found lying on its side, in curved semi-circular positions, within the first two inches of top soil.

Life History of the Grass Grub

The female adult Chafer beetle tunnels into the ground to a depth of three to seven inches and lays clusters of up to forty eggs. The whitish eggs can be seen with the naked eye, and are oval in shape, being covered with a sticky substance that sticks the eggs to the soil. The eggs hatch into the larva or grub which goes through moulting stages.

(a) First stage—four to five weeks. Found below the top two inches of soil.
(b) Second stage—five to ten weeks. Found in the top two inches of soil.
(c) Third stage—February to October. Found near the three inch mark.

Each stage is found in the different layers of top soil, so that no roots are left half eaten. In areas where the grub is present in large numbers the third stage larvae may be found just underneath the grass which can be rolled back like a mat. The pupal stage lasts from four to six weeks. The pupa, in an oval earthen cell, is found down to a depth of ten inches. When suitable conditions prevail, i.e., warm and dry, the Chafer beetle emerges. However, it may wait in the pupal case if conditions are poor, before emerging to the surface.

Things to Do

Find out where grass grubs are found (wilting patches on the lawn). How far down in the soil are grass grubs found at different times of the year? What part of the plants does the grass grub eat? What are the grass grub's enemies? e.g. birds, parasites, eelworms, larvae of ground beetle and robber fly. Describe and draw a grass grub, papapupa and Chafer beetle. Keep some grubs in the classroom and watch the beetles emerging. A "home" similar to the wormery will serve for this purpose.

A Lawn in the Classroom

For a closer look at earthworms, grass grubs, vegetable caterpillars, etc., "a lawn" can be set up in the classroom. Select a healthy clod of turf and place in a suitable tray, preferably made of iron or plastic, as wood will rot. The tray should be deep and have adequate drainage and conditions similar to those outside, e.g., moist, strong sunlight when necessary. The number of animals kept should be limited according to the dimensions of the tray. Grass grubs practise cannibalism if food is scarce. A diary of events that happen in the "lawn" is a useful record. A plastic cloche, or similar covering, will enable you to have winged, or jumping, insects on your "lawn".

The Porina Moth

The larva of the Porina Moth is the bright green vegetable caterpillar which is about three times larger than the grass grub.

A Surface Eater

Although the caterpillar lives in a vertical tunnel, six to ten inches in length, it does not feed off roots, but comes out at night to feed on the parts of plants above ground. This feeding habit helps us to distinguish the vegetable caterpillar from the grass grub. The adult moth emerges in October, going through the usual egg stage, three to five weeks; larval stage, November to July; and pupal stage, July to October. The adult moth does not feed; in fact the mouth parts are undeveloped. When burrowing their tunnels the larvae deposit crumbling casts near the entrance which are often mistaken for the smooth casts of earthworms.

Comparing the Grass Grub and Vegetable Caterpillar

If both grass grub and vegetable caterpillars can be found within the same area, compare and contrast with one another to bring out the main characteristics of each.

Grass Grub	Vegetable Caterpillar
Adults are small, shiny brown beetles about $\frac{1}{4}$in. long.	Adults are about 1in. long and dull grey or brown moths, which fly to lamps inside.
Beetles emerge in November-February.	Moths emerge October-November.
Beetles feed vigorously, e.g. on fruit tree leaves, or shrubs.	Moths cannot feed.
Eggs are large, white and deposited in deep soil.	Eggs are small, at first white, but soon turn black; laid on the ground.
Grubs feed on roots and vegetable matter below ground surface.	Caterpillar feed on surface for first four to six weeks, but later construct tunnels into ground. They feed only on parts of plants above ground. Caterpillars feed mainly at night but may carry grass down tunnels and feed on this during the day.

(iii) Our Winged Friends and Foes

Let us now talk about the birds found on our lawn. For attracting birds a moveable bird table is an invaluable aid. The birds alone are worthy of a separate study, but let's see how they affect the animals we have been talking about.

On our lawn we will find thrushes, sparrows, goldfinches, chaffinches, and perhaps one or two greenfinches or magpies. Observe these birds. What are they looking for and eating? Do they search for food in flocks, pairs or singly? How do they go about looking for their food—by fossicking amongst the grass? diving down after sighting their food? stopping and looking?

A Year-round Study

Birds may flock in winter, change their dress in autumn and spring, move with the seasons; and for these reasons the birds on the lawn can be studied all the year. Once again the diary form of recording can be used to advantage because it shows what happens to each particular kind throughout the year.

How the Thrush Hunts Worms

The thrush is often seen with his head cocked to one side in a "listening attitude", but really he is looking for worms. The thrush's eyes are on the side of the head. To get the best field of vision close

up the thrush has to turn its head so that its eye is directed straight down. The centre of the eye has a greater number of visual elements than any other part of the eye. To get the maximum efficiency the light has to strike the eye's centre at right angles; the bird turns his head for this reason. This type of vision is called monocular.

Note.—The Pastures section of the Dairy Farm (page) should also be referred to as part of Grasslands study.

THE ROADSIDE

Derek McKay

The Roadside may appear to be a bare and uninteresting place, or at least that was my impression before I started to explore it. Exploration led to discoveries and discoveries to a real thrill of learning just why certain kinds of animals and plants live where they do. You and your class will get the same enjoyment as I did if you but try.

Impressions:

The child's concept of the roadside is bound to differ markedly from yours. What is yours anyway? Perhaps your class will come to light with suggestions such as—

"The council mows the grass every spring."

"Jim and I have a hut and hide in it."

Some play hide and seek, cowboys and Indians, some even tie the grasses over to make traps for the unwary. Others play ball on the footpath and still others sail boats in the gutters and dam them up when the rain falls.

Taking all this, and more besides, into account we can see that the children spend a lot of their time on the roadside, whether it be in town, the suburban area or out in the country.

Children are Inquisitive:

All children want to know how, when and so on and even you as a teacher may quite rightly ask these questions. What lets life continue in such an area where children romp, where people work, cars park and drip oil, where devastating ditch floods rise in seconds and recede just as quickly, leaving a parched desert? How can plants withstand the chop-chop of the council mowers and the grazing of cattle? In some patches there will be no grass. The footpath may be bare or seedlings may be pushing their way through fractures in the sealing. This could also be the case with the road.

A quick glance at a roadside will show you that most of these areas contain some, if not all, of the following: a fence or hedge, a grass strip (waste or lawn), a sealed path, ditch, verge and road proper. These may all be included in one study, different teams exploring each area with the ultimate aim of telling their class mates all about it.

I shall deal with each specific area in turn. Should you think this undertaking impossible because of the equipment needed don't end it there, for I know if you but ask your class you will get all the equipment you need. Some of it can be constructed by the children themselves and they will derive much pleasure from doing this during Craft time, or even at home during their spare time.

How to introduce the study:

The study can be introduced by a visit with the class to a quiet roadside that you, yourself, have previously seen and given some thought to. The aim of this visit would be to reconnoitre the area and test its possibilies. Set the children to work for ten minutes or so and see what they can find. Their "finds" can be released with the promise that they can keep them when the proper facilities have been prepared—insect boxes, terraria, flower pots, etc. A successful visit at this stage will determine whether or not the venture should be undertaken.

Equipment:

The essentials for the children are keen eyes, active fingers, and an innate inquisitiveness. Remember that the only way to find things is to look for them.

An insect net is very handy for catching insects on the wing, but it is not essential. A simple net can be made using a broom handle, a length of thick wire, shaped and bound to the handle, and a net of soft material sewn to the wire frame.

A sieve is very handy, and someone in the class is bound to be able to bring one. If several can be brought try and get a fairly fine meshed one as well. The type of sieve I mean is that used by builders.

A sheet of white material is desirable. If it is possible, have the material made into a bag eighteen inches square and about two feet high. This is to receive the sievings.

Tweezers are useful for picking up insects, though much care needs to be exercised when doing this. The teacher should carry a sharp knife for cutting off branches and galls.

Trowels are also needed for following the underground tracks of burrowing animals.

Records:

Some means of keeping records is essential. A cheap notebook fulfils this purpose admirably. It is a very good habit to jot down notes on things that are seen and add sketches, no matter how rough, as well.

Apart from the jottings be sure to note the date, where you went, what you saw and what the weather was like.

Remember, too, that many truths about nature have been discovered in people's nature jottings in Nature Notebooks.

Specific Areas:

The hedge and trees. This vastly interesting place can be a study in itself. An invaluable piece of apparatus to explore the hedge with is an umbrella. This can be opened, inverted, and placed under the branches to be shaken. The shaking operation completed, the umbrella is closed and a wide necked jar is placed over the "open" end of the brolly whose contents are then shaken in. Most of these creatures can be kept in the classroom, using the plant they were found on as the host.

If any larvae come out of the hedge, or tree, try keeping them in an insect box, remembering that in all probability they will feed on the plant upon which they were found. If you don't have an insect box then ask one of the children to bring a shoe box. A gauze top over a large preserving jar works well too. If the host plant will grow readily, plant it in an earthenware pot and put an old-fashioned type lantern glass over it and bury it half an inch or so to prevent the larvae from escaping. Cover the top with muslin or similar material.

Even if the host plant won't grow, a similar habitat can be made by sinking a slim pill bottle into the pot, filling it with water, putting in some sprigs of the plant and packing the neck with cotton wool to prevent the larvae from getting drowned.

Some caterpillars can be kept on the host plant by wrapping part of the branch in clear plastic or polythene. Alternatively the children experiment with their own idea of how to keep them. The condensation of moisture may complicate observations, but this could be an ideal time to open up the whole field of plant feeding and breathing if you so wished. Ask the children where they think the moisture came from and so on.

Look into hedges and trees for rotting branches, for these crevices hide many creatures which can be interesting to observe.

In spring, birds' nests may be found in the hedge. More birds will nest here in the country than will nest in the town. Blackbirds and thrushes will be most common and then hedge sparrows and waxeyes. House sparrows may nest in larger hedges and trees. Should a nest be found tell the children not to disturb it, but suggest that it would be fun to keep a diary of events of what happens and being careful to make notes of even the smallest details. A useful book is Perrine Moncrieff's "New Zealand Birds and How to Identify them".

The blackbird's nest is of conventional shape, and has an inside layer of straw and grass with a binding layer of mud between that and the outside. There are usually four or five dirty sea-green eggs with brownish spots which are incubated for two weeks. Note if the bird sitting on the nest is away at certain times of the day and whether or not the male stands nearby on guard. The two sexes can be easily distinguished as the male is a bright black with a bright orange beak—the female is a creosote brown. Young birds are similar to the female.

The thrush is similar in size to the blackbird, but the sexes are indistinguishable, except to the experienced ornithologist. The nest is the same size as the blackbird's. The inner portions are characteristically lined with wood or mud pulp, made by masticating the rotten wood in its mouth. The female thrush lays four to five bright blue eggs, approximately three-quarters of an inch in length, which are spotted with dark black. Observe as suggested for the blackbird.

The nest of the native waxeye (alternatively called Silver Eye, White Eye) is often found low down in the hedge and in amongst the foliage, rather than in the branches. It is quite small and characteristically lined with horse hair, or if this is not available, then very fine roots. On the whole, it is a very frail nest and is not built up of thick layers as is the thrush and blackbird's. It is not built in the fork of a branch, but is suspended on two sides. The waxeye lays three to four small pale blue eggs.

The hedge sparrow, often confused with the female house sparrow, makes its nest in a similar position to the waxeye. The nest is not so fragile as the latter's and is built more of straw and is much larger in comparison. The female hedge sparrow lays four to six turquoise-blue eggs.

The nest of the house sparrow is very easy to identify. It is a large ball of coarse straws, cigarette papers and boxes, feathers; in fact, it is built of anything that the bird can find. Entrance is gained by a hole in the side, which opens into a downy, feather-lined cavity where the eggs are laid and incubated. A clutch of about five small greyish-white eggs, shaded with darker grey and spotted black, is laid. When the young leave the nest another clutch is often laid, so don't be in too much of a hurry to remove the nest for examination. If another clutch is laid, note the date and period of incubation. The sparrow may even surprise you by laying a third clutch of eggs!

An Activity Using Old Birds' Nests:

When you are absolutely certain that the birds have finished with their nest, a great amount of enjoyment can be had by removing it and analysing its components. Each different material should be separated and the children could construct a paragraph showing the different amounts of material used, either by volume, weight or percentage. They could also find the weight of the heaviest article in the nest.

Grass and Footpath:

Many insects live in this zone, especially in the grass waste. A comparison can be made between insects found in the hedge and those in this area. A similar investigation can be made concerning the plant life too. For example, it will be noted that the plants in the hedge will tend to be taller and more spindly than those in the grass waste. Why? Are they supported? Are they looking for

the light, or what? Set one of your teams to explore this area, but give them some guidance as to what to do and look for, using some of the methods outlined in this section. Most of them will tend to make for the grass, but let them know that the footpath is in the area too.

One problem to be solved is that of discovering why there are fewer insects in some areas than there are in others. Such clues as—no cover, too wet or dry, may present themselves. Some animals, like the web-spinning spiders, prefer to be at a reasonable height from the ground whilst others, earthworms, slugs, grass grubs, black nocturnal beetles, prefer the depths and dampness of the ground. Some which live on the footpath are burrowers and remain in their burrows to protect themselves from the hot sun, only coming out in the evening.

Draw the children's attention to the fact that sometimes the footpaths get so hot that even they prefer to walk on the grass at the side.

A common footpath burrower is the ant. These fascinating creatures have been the subject of many books, but you and your class will reap a greater joy by removing one of these ant nests, being sure to include the Queen, transferring it to a jar with a little soil and setting up an "ant nest" as described in the "Nature Study Handbook for Teachers", by D. Beggs.

This could become a permanent exhibit on the Nature Table. Besides being sure to include the Queen, include also the larvae and pupae, small white oval structures approximately the same size as the ants themselves. This is another activity which can be given greater meaning by the keeping of a diary of daily events. Ants are most common in February and March in sunny situations. They can soon be detected on the footpath by the little mound of soil they make around the entrance to their nest.

A problem for the children to solve is that of discovering what the various insects and animals feed on, but don't let it stop there if your class is really keyed up, but once having found the eater, find out what he eats and so on until you come to a full stop. If this venture is successful the children will come to the right conclusion, and that is that all life can be tracked back to the soil.

A simple poem to give this study a more understandable perspective would be "This is the House that Jack Built". This helps to show the child the interdependence of living things. This interdependence is seen in a more tangible form in such activities as a bee pollinating a flower or a waxeye removing scale from a fruit tree.

More Problems:

Another interesting problem is to discover whether or not the roadside plants are growing more vigorously than their brothers and sisters in your garden at home. If they are, then try and

find out why. The best way is to compare the soils in which the plants are growing and to examine them for any material they may contain. The soil in which the roadside plants are growing will be found to be damper. Why? Because the covering of plants and the covering of old leaves off the plants keep the sun's rays out and so help the soil to retain its moisture. An examination of the first few inches of soil will show the remains of many decomposed leaves and insect bodies in a similar state. This is humus, a valuable food for the plant. We could almost describe the plant as a cannibal for its feeds on its own dead!

The work of a pathologist could be mentioned here, and if the children are sufficiently interested they could try and identify the remains of insects found. In fact, they could hold a real post mortem.

City Streets:

If your school is city bound you could investigate the reasons for the gradual disappearance of most forms of life. Such clues as concreting, tar sealing and constant walking will help. Look in the cracks too. As you know, any plants growing there won't be allowed to reach a very great height before they become trampled underfoot, so remove them and try growing them in the classroom. Remember, as with all plants, only to transplant in the late afternoon or on a dull day. Ask the class if they know why.

Walls are more common in city streets and these "support" mosses and lichens. Remove these for observation in the classroom. Mosses must be kept watered. The most obvious features will be the formation of spores. These brown oval capsules form at the end of a slender stalk which is about equal in length to the moss plant itself. Keep them under constant observation, using a magnifying glass. Watch for the spreading of the spores and any consequent germination. Study the plant itself. Notice that the dead leaves are near the base and the newer ones near the top. Draw it.

Common Grasses on the Roadside:

Yorkshire Fog (*Holcus lanatus*). The leaves are quite velvety and have red and white veins at the base of the leaf sheath. The feathery seedhead is of a pale pink colouration. It usually thrives in damp conditions, and is only considered as a weed where it displaces useful grasses.

Browntop (*Agrostis tenuis*). This grass is commonly used in lawn mixtures. It grows to about 18 inches in height and has a delicate feathery brown flower head. It is twitch-like in habit, and its underground stems give rise to many shoots, hence forming a very close turf. The leaves are very fine, soft, short, triangular.

Timothy (*Phleum pratense*). This grass is identified by one or two bulb-like swellings just under the ground and just above the roots. The leaf has a bluish tinge.

Prairie Grass (*Bromus catharticus or B. unioloides*). This grass has broad green leaves, usually hairless but the leaf sheath has a hairy covering. It is usually recognised by the seed head, a fairly large structure, with seeds attached to a main stem by another short stem.

Cocksfoot (*Dactylis glomerata*). This broad-leafed grass is perfectly hairless. The leaf sheaths at the base of the plant are folded together into a very much flattened shape.

Using the Equipment:

The sieve is used for sieving the rubbish, etc., from under the hedge and the soil on the roadside. The bag previously described is to sieve into. Using this will enable you to see quite easily any animals that are sieved out. Remember also to look at the coarse sievings before you throw them away, as there could well be larger animals in there.

The Pavement:

People walking on the pavement tread on insects and crush them, and on slugs, slaters and other small animals. These provide food for other animals; we could almost call them "sanitary inspectors"! If you notice any of these crushed creatures, note their position and see if they have disappeared next morning.

Another interesting activity is to make a collection of shadow pictures. You will notice that the sun throws shades of grasses onto the path. If you place a piece of paper on the footpath the shadow will be thrown onto it and great fun can be had trying to get the outline traced before the sun (and the shadow) shift.

A flowering plant, such as a dandelion, can be kept under observation and a chart of its development made. Many flowers can be entered on it and a complete chart should be a matter of pride.

Key	Flower	October						November					
1. Flower opened		5	10	15	20	25	30	5	10	15	20	25	30
* Shed pollen	Clover												
S Died													

Slugs, Snails and Slaters:

These animals are found under almost any rolling material or under some bushy plants.

Slaters can be kept in a plastic lunch box, but they must have some damp vegetation to keep them happy. A little compost would be ideal.

Snails can be kept in a plastic container too, but they need no food as they will hibernate. When they are required for a lesson they can be activated by being put in warm water for a few

moments, then removing the mucus around the aperture. To feed a snail you can use almost any green stuff. You can even ask the children what it eats in their garden at home.

Be prepared to answer such questions as—Where was it found? Who found it? What does it do? and so on. The children could make their own snail homes and bring snails to school to put in them. The snail can be likened to a caravan dweller, who takes his house everywhere with him.

The children's observations can be directed by questions (or problems):

1. How many feet has a snail?
2. How does a snail cling to the wall? Why can't you?
3. Where is the silvery trail coming from?
4. Can you find a breathing hole?
5. Where are the snail's eyes?
6. What happens if you touch them?
7. Can the snail pull in one eye at a time?
8. Where do snails like to live?
9. What do they like to eat?
10. How many colours has your snail shell?

The Ditch and the Road:

This area, like the city wall, is almost a desert, but in some cracks, grasses and weeds grow. These are usually the same type as found on the waste, but some foreign ones do make an appearance. What are they? Where did they come from? How did they get there?

Mosses are abundant here and should be treated as for those that are found on the wall as described under "City Streets".

A most interesting activity is to collect soil and mud from several places in the ditch. Keep it damp and in covered saucers. See how many different plants come up. If it is possible, transplant the seedlings in a pot or seedbox containing sterilised soil. Remember to note just where in the ditch you got the soil from.

Between the ditch and the road there will be some pretty hardy plants—ryegrass, wire weed, and broadleaf plantain. The main thing to note is the conditions under which these plants live —constant trampling and running over by vehicles.

All in all, you should find this area most interesting, but perhaps I have given too much for you to do. The best thing you can do when you have read this is to be like the dog—eat the meat and leave the bone, and I'm sure you and your class will enjoy it.

Bibliography:

Nature Study—A Handbook for Teachers—D. Beggs.
Pasture Plants and Pastures of New Zealand—
F. W. Hilgendorf.

THE WASTE SECTION

Doreen Brady

Have you a suitable place near your school on which you could base much of your Nature Study for the year? In most cases the answer will be "Yes—that waste section nearby". But perhaps you have never thought of using it as a study area, a real outdoor laboratory. If not, then now is the time to try it out. It can be the source of much profitable interest for all classes.

In this study I propose to outline a few methods and approaches which may be adapted for use in your own particular environment. Your waste section may be in the city or in the country, it may have a tumble-down house on it or the house may have been demolished or again, it may not yet have been built on. All these have their own particular advantages and will require different methods of approach and study.

Many of the topics in the Syllabus can be studied to advantage in the waste section. Weeds, climbing and shrubby plants, birds, insects, and other small animals can be found there in abundance with maybe a tree or two as well.

Suggestions for Infants:

(1) Adopting baby plants (mark with a stick). Watch them grow, flower and seed. Some of the weeds grow very quickly and are ideal for this.

(2) Collecting seeds and growing them on the nature table. A pressed specimen of the plant they were taken from could be kept for reference.

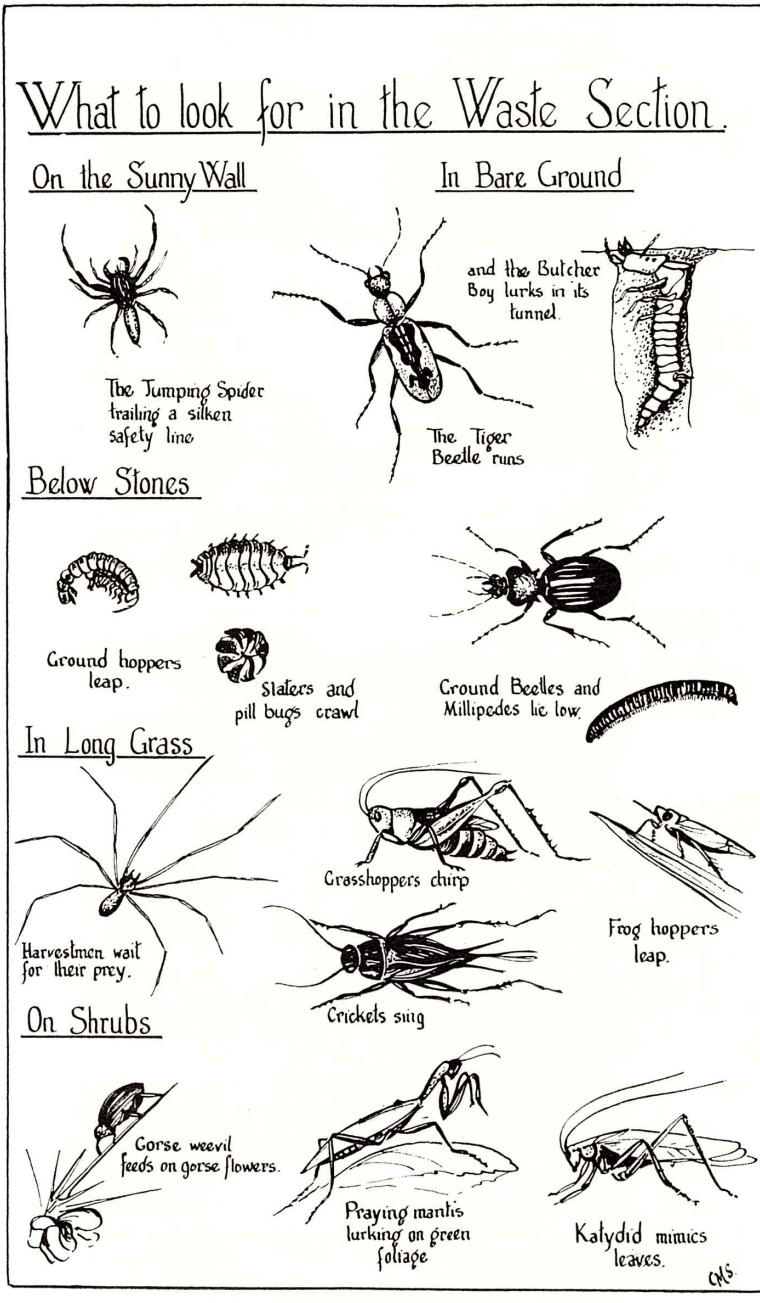
(3) Matching games with leaves and flowers.

(4) Treasure hunts—teacher holds up specimen, describes it, children then sent off to find their own specimens. What is its name? If no-one knows the name, discuss the plant and make up a suitable descriptive name.

(5) Study of animal "homes" which can be set up on the Nature Table, e.g. the spider in its web. One in an insect box (well ventilated) may be induced to build. A nursery spider's nest could be watched on the table or outside. The mother spider may often be found just below the nest. Encourage the children as they pass the nest to see whether she is "at home".

Long grass is a home for many small animals. Set the children hunting for them.

Below large stones or boulders—a damp home for slugs, worms, slaters, etc. Worms also like to burrow under the ground. Some time when the ground is damp, set the children looking for worms and set up a wormery in the classroom.


What to look for in the Waste Section.
On the Sunny Wall
The Jumping Spider trailing a silken safety line
In Bare Ground
and the Butcher Boy lurks in its tunnel.
The Tiger Beetle runs
Below Stones
Ground hoppers leap.
Slaters and pill bugs crawl
Ground Beetles and Millipedes lie low.
In Long Grass
Harvestmen wait for their prey.
Grasshoppers chirp
Frog hoppers leap.
Crickets sing
On Shrubs
Gorse weevil feeds on gorse flowers.
Praying mantis lurking on green foliage
Katydid mimics leaves.

Various plants are hosts of insects—groundsel for the woolly bear caterpillar of the magpie moth, nettle for the red or yellow admiral caterpillar.

A bird may be discovered on its nest and the sequence of events observed. These may be recorded pictorially and in writing in the classroom.

A nest of ants may be kept for observation in the classroom. For instructions see the "Nature Study—Handbook for Teachers" by Beggs, p. 149. Ants' nests may be found beneath stones in sunny places.

Suggestions for Standard Classes:

Mapping the Area: Older children will be able to map the area on their own, but younger ones will require the teacher to do most of the work. A map will be of more interest in relation to some areas than to others. Link finds and other displays on the nature table to their places on the map. Flag-label things to watch. A quadrat or transect may prove more interesting. Quadrat-mark out a small area (say a square yard) and map out all the plants growing in that area. Transect-sketch a piece of string across the area and record all the plants growing along the line. This could form a frieze and contain drawings or pressed specimens of the plants. The making of quadrats or transects could be group activities and results can be compared.

The younger classes especially will enjoy keeping diaries—related to one animal or plant, seasonal activities and changes, or just interesting discoveries.

Children are inveterate collectors. Collections of pressed specimens of weeds can be made. These could be mounted in the form of a frieze for identification purposes. Seeds could also be collected in the autumn, and stuck down with clear plastic tape or sealed in tiny transparent envelopes.

Some of these plants can be studied in detail. Grow seeds on the Nature Table on blotting paper, in soil, with and without water, under water, in dark or light (children will think of many variations which correspond with conditions on the waste section) and record the growth of each lot.

Animal studies—class study of animals in the Syllabus. Observe adaptations to environment, usefulness or otherwise, enemies and those it preys upon.

The General Appearance of the Waste Section:

Here is a place where animals and plants have been relatively undisturbed for months and maybe years. Here there is no avid gardener removing viciously any poor weed that may chance to come his way. No, weeds of many kinds are left in peace to produce their flowers and set their seed. Peace from man, yes, but peace from insects and other small animals, no. The woolly bear caterpillars eat away at the grounsel until they are

ready for the transformation into magpie moths, snails and slugs are free to rasp away at whatever vegetation takes their fancy, and gorse weevils can destroy gorse seeds to their hearts' desire.

Perhaps you are a bit over-awed by the whole picture. Why not divide your class into groups and let each group study a different aspect of the area? Here are some suggested areas that you could choose, and some problems which you could give the children to solve are briefly outlined.

1. *A Sunny Wall*: Not much scope here you may say. But just sit and watch. See all the flies coming to sun themselves. What happens when a shadow passes across them? Yes, they are easily frightened. They are hunted animals. Test their field of vision by movement all round them. You will see that they have a very large field of vision to see enemies approaching from all directions. Move your hand or a stick slowly closer to the fly. How near can you get before he flies away? Try again, moving quickly. You will notice that the fly can spot a faster moving object from a greater distance. Notice the very large eyes—the most noticeable part of the head—specially designed to detect movement.

I mentioned before that flies were hunted animals. Thus, to the sunny corner, following the hunted, comes the hunter, spiders of all descriptions, some building webs, others not. Mantids also come looking for flies and you may be lucky enough to find one of their egg cases on the wall.

With insects represented by mantid sand flies the differences between them and spiders can be listed.

2. *A Shady Corner*: The conditions here are naturally damper than in a sunnier place, and so the plants have a brighter, greener, juicier look about them. On the whole, leaves are larger so as to catch the maximum amount of sunlight.

These plants provide shelter for animals which like cool, moist, dark places—snails, slugs, planatarians, slaters, soil hoppers, and many others. A piece of rotting wood or perhaps a large stone in this area should have an interesting population beneath it.

Study the similarities and differences between the closely related snails and slugs. How are they suited to damp living conditions? What happens to snails when they dry up? Put some in a dry preserving jar for a while? Do they die? What happens if you put these in warm water.

Study all these animals in relation to their environment. How are they adapted to live there? What are their good and bad points? Which are welcome in our gardens? Which are insects and which are not.

3. *In the Long Grass*: Grass springs up very quickly and provides shelter for animals and also other plants to grow up. Collect specimens of all the grasses you can find and try to identify them. Most can easily be identified by using Hilgendorf's

"Pasture Plants and Pastures of New Zealand". Watch for grass flowers and compare them with more typical flowers.

Look at the plants growing up among the grass. Are there any which climb, using the grass as support?

Get right down into the grass and look for animals. Grass spiders and harvestmen should be common. Look for the insects on which they may feed, froghoppers and others. Look for spiders' webs strung out across the grass. Can you see any differences between spiders and harvestmen? The most noticeable difference seems to be that the harvestman has only one part of its body, while the spider has two.

4. *Bare Ground*: This area is often in a sunny situation where the soil is very shingly and the ground has a hard, dry, caked surface. Very few plants will grow here, but those which do are worth noting. I have found mostly those with rosette habits growing here. The rosette of leaves seems to hold moisture in the soil and towards the edge of the bare patch more of these plants are growing and the soil loses its baked appearance and gradually merges into the vegetation covered region.

Can you find any holes in the bare ground? These may be the homes of the "butcher boy" or "penny doctor", larvae of the tiger beetle. If you watch the holes quietly you may see these larvae as they peep out of the hole to trap insects which come within their reach. Pull them out on a straw or dig them out to observe their anatomy. The tiger beetle itself may also be seen darting about.

Wolf spiders can also be found running around. Some may be carrying egg sacs and others may have young riding on their backs. These are hunting spiders which build no webs.

5. *A Heap of Rubble*: A heap of rubble soon becomes covered with vegetation—often climbing plants such as convolvulus or blackberry. These plants shelter many of the animals discussed in other sections, e.g., slaters, soil hoppers, beetles, cockroaches.

Any empty tins on the heap may collect rainwater and become breeding grounds for the mosquito. You may find egg rafts, larvae, or pupae. Take these back to the classroom to watch the life history. Notice that the larvae (wrigglers) and pupae (tumblers) have to come to the surface to breathe. Put some in a jar with a film of oil or kerosene over the water to show how they are controlled by suffocation.

6. *Shrubs and their Populations*: Many shrubs will be found growing on waste sections. There is gorse with its enemy, the gorse weevil, which lays its eggs in the young pods. The larva which hatches out eats the seeds. To collect these weevils (and any other insects, spiders, etc.) spread below the branch a piece of white sheeting or white or brown paper and shake the branch

over it. Any animals that are shaken out will land on the sheet and be easily visible.

Broom and manuka are other common shrubs. Stick insects, katydids, or mantids may be found on the shrubs, the two former feeding on the foliage and the latter feeding on smaller insects which fly round in the sun. These three insects illustrate camouflage very well, the katydid and mantis resembling leaves and the stick insects, twigs. Slung between branches will be spider webs. Try catching a fly and putting it on the web.

Look for caterpillars on the shrubs. Some may be hiding in rolled up leaves. Take these back to the classroom, keep them well fed (with pieces of the bush you found them on) and watch the life cycle unfold.

Gorse is a favourite for the nursery spiders' nests.

Some of the taller shrubs or hedges may harbour birds' nests. Watch the seasonal activities around these.

7. *Climbers and Scramblers*: Why do these plants wish to climb?—to get to the light, a lazy way of being taller than nearby plants; to put flowers in a place where insects can see them for pollination, and whence the fruits can be easily dispersed.

Study the ways of climbing—a scrambling habit, using tendrils, hooks or roots. Convolvulus, vetches, blackberry, ivy, are examples of the four types of climber.

Spiders: The Waste Section is an excellent hunting ground for spiders of many different kinds, so a brief list of the various kinds of spiders will not be out of place here.

A. *Web builders*: Spiders which build a web to ensnare their prey. They rely on vibrations from their web rather than sight to identify a prospective meal.

(i) Orb Weavers: The perfectly constructed webs of this family are a familiar sight to us all. How wonderful if one of your class were to discover one of these tiny engineers building her snare. Perhaps you have come across a spider waiting in her snare (or she may be waiting nearby). Can you catch a fly or other small insect and stick it to the web? The sticky threads of the web are the spiral ones which are spun last of all.

The males are not found so commonly as the females, which may be larger. The males have knobbed palps.

(ii) Cobweb spiders: Everyone knows the untidy tangle of web often found in corners of buildings, below which its engineer hangs in wait for its meal. The well-known katipo is one of this family.

(iii) Sheet Web Spiders. These have thin legs, usually with spines. Their snares are in the form of a sheet on the ground which traps vertically flying insects. The webs are most noticeable when they are covered with dew.

(iv) Funnel Web Spiders: A tubular retreat leading back from a sheet-like web is the lair of this spider which rushes out when an unwary insect, trapped in the snare, sends vibrations in to him. They are often found under eaves of buildings, below stones or logs, and in hedges.

B. *Hunting Spiders*: With their keener eyesight these spiders, unlike the lazy web-builders, stalk their prey. They may use silk to build retreats or egg sacs or to bind trapped insects.

(i) Wanderers. These two-clawed hunting spiders make tubular retreats in rolled up leaves or under stones. The males and females are very much alike. They are mostly one colour—yellow or brown.

(ii) Wolf Spiders. The female wolf spider may often be found carrying her special egg sac, or perhaps her family, for when they hatch out the young climb on to their mother's back and ride round there for about a week. After that they require food, so they disperse. The wolf spiders do not build webs to catch their food, but some may build silken retreats in the ground.

(iii) Crab Spiders. These have wide, spreading legs and stalk their prey. Green ones are found on gorse.

(iv) Jumping Spiders. The jumping spiders have the keenest eyesight among the spiders and stalk their prey until they are fairly close and then they jump and pounce. Their silken retreats for moulting, hibernating, or spending the night may be found under bark, beneath stones, or in rolled up leaves.

(v) Nursery Spiders. Another family of hunters, the female carries the egg cocoon around with her and just before the spiderlings emerge she fastens it to some leaves, builds the familiar nursery web around it, and stands on guard nearby. Some of the family may be found on or near water feeding on aquatic insects.

(vi) Trapdoor Spiders. These spiders build an intricate "trapdoor" of silk, disguised with pieces of stick and moss to close the entrance to the tunnel. Just below this lid, peeping out, lies the owner of the tunnel, waiting patiently for a passing insect. He never completely leaves his tunnel in the search for food and if disturbed can hold the door down very firmly.

How to Hunt for Spiders:

Choose a fine, sunny day, any time of the year, and set off armed with jars, a tuning fork, and a water spray. Secateurs would be useful for collecting an orb web built between a forked stick. A tuning fork, vibrating against a web, will often bring out the owner post haste. A spray of water picks out a web more conspicuously.

How to Care for Spiders:

Spiders should be set up comfortably on the Nature Table with perhaps a bit of soil in the bottom of the jar and a few sticks. Although they can do without food for quite a long time they need water often, so add a drop or two each day. Remember—spiders are cannibals—so only one to each jar! An orb weaver may be induced to spin a web if provided with a forked stick and a draught.

For Reference:

How to Know the Spiders	B. J. Kaston
Spiders	W. S. Bristowe
Insect Watching	J. C. Andersen

HEDGES

Elizabeth R. Samuels

There are, generally speaking, two kinds of hedge—the town hedge and the country hedge. Have you a hedge in your environs? How much nature study have you ever thought of basing on it? A hedge usually starts as a row of woody shrubs planted for shelter or privacy. It is not long though before it becomes a community of plants and animals, all depending on each other for life.

The choice of plants for the hedge is governed by the climate of the district but they are usually hardy plants, able to withstand a great deal of abuse and give good thick foliage after hard clipping. Hedge plants are often but not always evergreen.

The best time to conduct a trip to the hedge would be when the plants are flowering. Note where the animals are found. Most will be on the sunny side where there is warmth and food in the form of nectar and foliage. The cooler, shady side may have insects in mid summer but is unlikely to reveal much at any other time. The predominance of animals on the sunny side is an interesting topic for class discussion.

There are three usual types of spiders found on hedges:

(1) The SHEET WEBBER which spins his web on the top of the hedge to catch ascending insects.

(2) The FUNNEL WEBBER which spins a funnel-shaped web with a silken platform at the front. The insect lands on the platform and causes a guide line to vibrate, instantly attracting the attention of the spider. The web is made on the sunny side of the hedge.

(3) Also on the sunny side of the hedge is the ORB WEAVER'S web. This is of the typical cartwheel pattern. The spider sits at the end of the guide line and waits for the vibrations which indicate a catch.

The inside of the hedge is very sparse. It is a mass of dead twigs. There are a number of lanky plants growing up, through the centre to the top of the hedge, where they flower. Notice the long internodes of these plants. What is the reason for them? Is it advantageous for the plants to be at the top of the hedge because they get the sun, and there is better chance of pollination and seed dispersal. Note that most of their leaves are above the hedge.

Below the hedge, where the bare trunks prevail, it is more open, and here we find the base of grasses such as Prairie Grass and Cocksfoot, and of such plants as Cleavers and perhaps Convolvulus. The grass stems in and near the hedge form a microclimate in which we find broad leaved plants, such as plantain, and moisture-loving plants, such as mosses and liverworts.

In the leaf mould we find scavengering insects which eat slugs, worms and decaying plant and animal matter. Darkness dwellers such as ground beetles live in this situation where the fermenting plants, in the act of breaking down, are giving warmth as well as food and protection. The fermenting leaf mould is a good nursery for insect larvae.

THE TOWN HEDGE

The town hedge is usually well clipped with dense foliage and very few other plants fighting for existence. Spiders can be found in great numbers. They provide a fascinating study. Hold a vibrating tuning fork to the guide line of a web. What happens? Why? Why do these spiders choose the hedge?

Flowering hedges such as Lonicera, Abelia and Tecoma attract such insects as bees, hover flies, and butterflies. What do they come for? What is the significance of the presence of predatory insects such as Praying Mantis, Katydids and Stick insects? What are the birds most commonly associated with the town hedge? Why are they there?

Keep a seasonal calendar of your hedge and find what animals visit the hedge at different times of the year. How do you account for variation? What plants have palatable berries?

If your hedge has dead and decomposing leaves underneath, you will probably find slaters and worms—both good for study and both part of a hedgehog's diet. Look carefully for signs of recent habitation by these mammals.

Hedge sparrows and blackbirds can often be observed hunting round in the dead leaves. What are they looking for?

A FIELD TRIP TO A CITY HEDGE

When to go

The best time for trips to the city hedge is when the plants are in flower or in fruit. The reason for this is that the pattern of life is more easily followed. Small, and not so small, insects come to collect nectar. Larger insects, spiders and birds are to be seen

waiting to prey on the smaller animals. Summer is usually the best time for insects. A sunny day is the most desirable for the best observations.

Look at the hedge after a heavy dew. How many different shaped webs can be found? Have groups drawing the different patterns and trying to distinguish between the spiders which made the webs. Get them to note the significance of the position of the web on the hedge.

How to work at the hedge

There are two general methods. Both benefit from a teacher's introductory outline of what they might find and why.

The first method is one in which the teacher takes the class as a whole to the hedge and discusses various points of interest. He then divides the class into groups and gives each a certain length of the hedge to study.

The second method employs group studies of special subjects e.g., insects visiting the flowers; predators; insects on the ground; larger animals on the ground, e.g., hedgehog; spiders; bird visitors; the nature of the particular hedge will govern the studies undertaken.

Reports

Each teacher has his own proven method of record keeping. Group charts telling the story in pictures and a few words are effective in most situations. A class book on "Our Hedge" provides a good, general record.

Nature Table

Take insect nets and jars on your trip. These are handy for bringing back insects and spiders for the nature table. Set these animals up inside in conditions relative to their natural habitat.

Other nature table topics could be—hedge plant flowers; hedge plants. The children should be interested in bringing specimens from home. Where possible, always have plants labelled.

THE COUNTRY HEDGE

The country hedge gives even more scope for nature study. It is usually larger and less well cared for than its town counterpart. Some country hedges are never clipped after they have made four or five years' growth. Hawthorn is a typical example, with something of interest in all seasons. During the first term the leaves are changing colour, then they fall. The berries can be seen growing and changing colour. What birds come to eat the berries? As the leaves fall, notice how many nests are to be found. How many different kinds of birds nested in the hedge? How far apart are nests built by birds of the same species? In late winter and early spring note how birds claim their territory by song. Note the aggressiveness of the male blackbird if another encroaches upon his ground. See if you can determine where he

and his mate will build. Watch building operations. Do both birds build the nest? What do they use? How many eggs in the nest? What colour? How long before the young hatch? What do they eat? How do they get it? How long before they leave the nest? How long before they fly away?

Watch in spring for the flowers which precede the leaves. With the flowers will come insects followed by insectivorous birds and predatory insects.

The hedge creates a microclimate in which other plants grow. These plants vary with the locality. Some likely to be found are Bittersweet, Blackberry, Briar Rose, Convolvulus, Periwinkle and the native Parsonia and Pohuehue. Smaller plants are the grasses which supply food for the seed-eating birds with strong, crushing beaks. For identification of grasses, refer to Hilgendorf—"Pasture Plants of New Zealand" or Mackay—"Manual of New Zealand Grasses and Forage Plants". Chicory and Nipplewort are two plants which attract goldfinches and yellowhammers. These birds have bright patches of colour which act as camouflage rather than attracting attention to them.

The long grass provides a home for grasshoppers and crickets, which have powerful back legs to facilitate movement. What do they eat?

Two of the animals mentioned in the Standard Three Core are sure to be found near the country hedge. The Hedgehog will often be found in the grass and dry leaves hunting for insects. It has a long sensitive snout to help find the insects and other small animals on which it feeds. The body is covered with hairs which along the back are modified to form spines for protection. Spines are not needed on the underside because the hedgehog gains added protection by rolling up in the face of danger. Contrary to popular opinion the hedgehog is well able to run fast.

The Hare is another mammal found near hedges in the country. The adults may, to the untrained eye, resemble rabbits, but there is much difference in habits. The young hares, leverets, are born in forms on the ground. There is often only one to a form. The young are born with open eyes and fur covered bodies. Compare this with rabbits, the young of which are born underground, naked and blind, in a litter of four to six. What necessitates the difference? Hares, unlike rabbits and hedgehogs, cannot be kept in captivity.

There are likely to be stones and old logs near the hedge, lying in the grass. Have a look under them. You are sure to find such things as Ground Beetles and their larvae. Reconstruct the habitat and watch the life cycle. Slaters, Flatworm, Slugs and Groundhoppers will be found. Why are they in such a place? These plants as members of a community are of interest as a nature unit. Further study can be made by referring these plants and animals to the economy of man. What does the farmer think of them?

FIELD WORK AT THE COUNTRY HEDGE

The same general principles as for the town hedge apply. The same methods and group topics can be followed. Birds will play a more important role here. There is more scope for bird calendars and for prolonged studies of hedge mammals. Additional group topics would be plants in the hedge; grasses near the hedge; other small plants near the hedge; animals under logs and stones.

SPECIAL STUDIES

The Gorse Hedge

The gorse hedge is found in most parts of New Zealand. It is a host to the introduced gorse weevil. For information refer to Nature Study Bulletin Vol. VI No. 3, 1956.

The Macrocarpa Hedge

The macrocarpa hedge is host to the Macrocarpa Moth, the caterpillar of which provides an excellent example of camouflage. The caterpillar, which grows to a length of about 1¼ins., is a looper. It is green with the appearance of a small twig covered with scale leaves. The brown head is patterned to resemble a small seed cone. This is a record of the writer's observations:—

The caterpillars were collected on the 6th and 26th of April. Most of them were about 1 inch in length. They pupated from the middle to the end of May. The pupal case, which was brown, was formed inside a tent of macrocarpa twigs and silk.

The end of July and beginning of August saw the moths appearing. Three of the moths had cream and brown markings. One suffered an accident. The other two lived for nearly a fortnight, with no development, until another moth, this time with silvery markings, emerged. This moth was put with the other two. Two days later a number of eggs were noticeable along the stems of the macrocarpa and on the sides of the jar. The green eggs were singly placed. The laying process was not observed. One would imagine that colour indicates sex, but nothing has been seen to prove it. The eggs had not hatched a fortnight later, at the time of writing. The moths are still alive and being fed daily with honey and water solution, from a pipette dropper.

Golden Akeake

The native Olearia forsteri or Golden Akeake is attacked by the learia Gall Midge. Its life cycle makes an interesting study. The gall takes the appearance of a knobbly piece of cork on the young twigs of the plant. The midge lays her eggs in the bark. This has the effect of stinging the plant and causing an irritation resulting in the rapid multiplication of the plant cells. This is the gall in which the larva hatches and lives as a plant parasite, i.e., it has shelter plus suitable and abundant food. The gall in no

way harms the plant. The interesting fact is that the insect seems to direct the shape of the gall, the growth of which is entirely vegetative.

For classroom study keep twigs with galls in an insect box. Wait for development. The midge is so small that you must take care to cover all holes. When the grubs pupate, tie a polythene bag over the part of the plant attacked by the galls and keep a close observation on what happens. This method, apart from showing transpiration, should show emerged insects. Do not have the covered part in direct sunlight because the plant is likely to wilt. Keep a diary of events.

Reference:

Plant Protection in N.Z. (Technical Correspondence School), p. 433.

A Rose Hedge

Have you ever thought of having a rose hedge? If you plant floribundas you will have a good display of bright colour for most of the year. The plants will grow to four or five feet in height. The flowers provide good nature study. They attract birds and insects. The most common insects are bees; hoverflies; rose aphids, and ladybird "niggers" and beetles which feed on these. Roses have compound leaves—an interest in themselves. What would appear to be a leaf is really only one fifth of a leaf. The leaves are often infected with the aphids. Their unusual life cycle can be found in most books on insects. The four stage life cycle can be observed on the leaves and stems. Thorns are a means of protection from foraging animals. The colourful hips provide food for birds. The seeds can be easily sown and grown in river sand. They will usually flower within the year.

THE BUSH

D. Roberts

Most people, including teachers, when asked about a piece of bush think of it in terms of a tangled mass of vegetation. Something to be avoided at all cost. They do not seem to realise that in this same bush can be found the Nature Study programme for the year, a self perpetuating self maintaining project which eliminates the vague lesson to lesson Nature Study found in many schools today.

In this article I would like to outline ways of dealing with the bush in terms of classroom nature study covering native trees and how the Maori used them, the insects of this area and their natural enemies. It should be noted that this is a sample study, based on an area of local swamp forest. It would need modification for other districts, and other types of bush.

Ecology of the Bush

The term "Ecology" is applied to the concepts and studies of the interaction of living organisms one with the other and with their environment. Each plant or animal is in fact specially adapted to play its part in this living community. In the bush this interaction of living organisms is everywhere apparent. Many of the native trees such as the kowhai are dependent upon the birds like the waxeye for cross pollination. In turn the waxeye, while liking nectar, also has as its staple diet insects, which feed upon the plants and shrubs of the forest.

The keynote of this plant and animal community is balance; even though this centre of balance may shift. A sudden increase in the number of plant eating insects could have disastrous results unless speedily curbed by the insect eating birds such as the weka, fantail, kaka and grey warbler. In many cases the balance has been seriously disturbed with the coming of the white man, and it is only recently that the necessity for conservation has been appreciated. It is this ideal of conservation and care which should be presented to children in any nature study programme.

Part I—The Plants of the Bush

The Layers of the Forest

Any typical patch of bush may be tentatively divided into layers which give a general idea of the height, and characteristics of trees and plants within a particular layer.

1. Forest Floor

On the forest floor are to be found the ferns, mosses, lichens and young seedling plants hardly touched by the sunlight competing in the struggle for space in which to grow. Plants such as fungi and mosses are specially adapted to live in wet conditions, and so do not high light intensities to synthesis plant protein.

2. Shrub Layer

This layer may be composed of lemonwood, matipo and the intermediate stage of larger trees such as broadleaf and hinau. Such shrubs (or trees) in general expose a greater leaf surface to trap the more diffuse light. Rata, kowhai, and coprosma on the other hand present numerous leaves to trap the available sunlight rather than depending upon a large individual leaf surface.

3. Forest Ceiling

Forming and in certain cases the emergents of the forest are those trees which need the sun and can withstand its direct rays. Their leaves are tough and of xerophytic nature well able to resist the drying effects of the summer sun. Rimu, totara, and white pine all, without exception, have the small slender leaf and stem of the podocarp, which while resisting transpiration allows sufficient sunlight to penetrate to the forest floor.

4. Climbers

Joining together all layers of the forest are the climbing plants or lianes. Their diversity of climbing aids makes them a study in themselves.

Bush lawyer, a member of the rose family, climbs by prickles on the stems, and midribs of the leaves. In some cases its thickened stems twist about forest trees to support its great length.

Jasmine and rata both climb by means of aerial roots.

New Zealand passion flower provides a good study of a plant which climbs by means of tendrils. It is in fact characteristic of these plants that they have long contorted stems, very strong and supple and yet unable to support their own weight as they reach towards the light.

HOW TO TAKE THE FOREST WITH YOUR CLASS

A study of this type can be divided into the following headings in working with the class:

Introduction
The forest before the white man came
Field trip
Back in the classroom

LAYERS OF A GENERALISED MIXED BROADLEAF PODOCARP FOREST

	Forest Floor	**Shrub Layer**	**Forest Ceiling**
Conditions within a layer	Shady moist conditions. Very rich soil of leaf mould type. Holds water well. Little or no sunlight.	Small shrubs and trees having large leaves or small numerous leaves to trap sunlight.	Composed mainly of pines or podocarps. Small-leafed to allow sunlight to filter through; xerophytes, able to resist desiccation; needle-like leaves.
Flora found within a layer	Ferns— Shield fern (Richards) Necklace fern Bracken Spleenwort Hound's tongue	Coprosmas, Matipo (red and black) Lemonwood, milk tree Mahoe Lacebark Ribbonwood	Kahikatea Matai Rimu Pokaka Miro Totara

Joining all layers are the climbers—Rata, Clematis and others.

Living animals and insects are always good nautre study from the point of view of class interest and participation, but trees as a rule are a hard thing to arouse the interest of children. It takes a good teacher to maintain interest in a chalk and talk lesson on "deciduous trees" (e.g. "Trees in Winter"). For this reason I do not propose to deal with the native trees in this way but rather to take this topic in connection with social studies; in other words, how the Maori used the forests of New Zealand.

Introductory Lesson—"The Forest Before the White Man Came"

Describe how you think New Zealand looked in the early days and then let the children take the place of the Maori, using the following themes:—

1. Where would they live?
2. Where could they get their food?
3. What could they hunt in the forest?
4. I wonder where they got their materials to build their houses and to make their weapons, canoes, etc?
5. Finally what trees did the Maoris use?

This is the most important question from a Nature Study point of view and you will have built up your blackboard summary with this end in view.

What Trees Did the Maori Use?

Now put up a list of the trees the Maori used, drawing as much information as possible from the class. A good idea is to discuss the Maori and his needs previously in social studies. Or what could be more appropriate than to read some of the stories of maori mythology during the English period.

For a list of the native trees and their uses see Martin—N.Z. Nature Study, p. 144-147.

The Nature Table

During this period it would be a good idea to devote "The Plant of the Week" section of your nature table to a display of the forest trees you yourself have collected in the bush. A good heading could be "Native Trees and The Maori" and you could make out a card on this theme.

e.g. The Bush was the home and larder of the Maori. From it he obtained much of his food, clothing and shelter. Here are some of the trees he used:—

Taking the Lemonwood as an example, a typical card for the nature table could be as follows:

Lemonwood (Tarata)

This tree grows into one of our most beautiful native shrubs and is easily recognised by its wrinkled green leaves with a yellow midrib running down the centre. This tree blossoms in October to produce masses of yellowish green flowers.

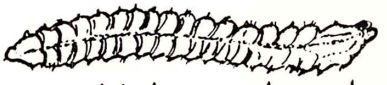
Things to do:—

1. Crush a leaf. What does it smell like?
2. Can you find a tree near your school?

Cards could be made out following this pattern and on the 5th week display all the previously shown trees without their names. Make it a group competition to name the various trees and to write something about them in the Nature Dairy.

Bush insects or spiders of the bush would give balance to your nature table display while trees are displayed over this 5 week period.

Muehlenbeckia Galls



Larva

Note reduced leg structure

An immature Gall

Mature Gall

Note escape hole of emerged moth.

Bush Field Trip

Having introduced your topic and commenced your four week nature table programme it is wise to make a practical study of the bush by taking a field trip.

1. Discuss the trip with the class, picking out six important trees you think the children should know, e.g. Rimu, tarata, mahoe, kohuhu, kahikatea, kaikomoko.
2. Divide the class into six groups of even numbers.
3. Explain that you want all children to see the trees and this necessitates each group moving from tree to tree in a clockwise direction.
4. Each group must change as a unit when the whistle is blown.
5. Work out with the children the sort of things we want to know and make out a question card to hang on the tree.

Typical Question Card

Kohuhu

(1) Sketch shape of tree?
(2) Draw a leaf. Is it wrinkled at the edges?
(3) What colour are the branches?
(4) Draw one to show leaf formation?
(5) What colour is the trunk?
(6) Can you see any flowers or seeds? Describe and draw.
(7) Is this a big tree as compared with an oak?

Equipment—whistle, secateurs, plastic bag, question cards.

6. On arrival establish a base camp and define the signal whistle for returning to base.
7. Make sure group leaders know where each base is, and if possible keep all groups in sight.
8. Move continually around the groups.
9. Reporting may be taken there or in the classroom.

Back in the Classroom

As a follow up, a good idea would be a "team discovery lesson" aimed at making a class book to record the finds of the groups.

Divide your class into the six groups, each group studying two trees. The study should consist of a drawing of the tree or twig, and a story describing the following features:

1. Where it was found.
2. How big was the tree?
3. Description of leaves, branches.
4. The size, shape and colour of seeds, fruit or flower.
5. Is this tree an "evergreen"?
6. What did the Maori use it for?
7. Maori legend associated with the tree.

Material Required

1. Bring back twelve different specimens for group study.
2. Paper for recording.
3. Books of reference.

Conclusion

Allow a period for groups to report their discoveries to the rest of the class.

Part II Insects of the Bush

The bush provides the natural shelter for a great many insect inhabitants. Here, under the bark of trees, on the leaves or in the leaf mould may be found a host of interesting insects provided one knows "where to look" and, of equal importance, "how to look".

Where to Look and How

In this section, I intend to highlight the various insect haunts of the bush and how to explore them. Before going on a trip you would be wise to equip yourself with collecting jars, match boxes, pocket knife, lenses, and a large sheet of white paper or plastic.

Insect Haunts

1. Logs and Rotting Leaves

Before rolling aside that moss covered log unscrew your collecting jars and study the upper surface for moths, scale insects, and cocoons. Tear off a piece of bark or roll aside the log. Earwigs, ground beetles, wetas and cockroach will run for cover. Though they live in comparative harmony, it is best that you keep the different species in separate containers. One golden rule must always be remembered; don't mix herbivores and carnivores (beetles, hunting spiders) in the one container. Check the bottom layer of rotting leaves, for here you are bound to find the hunting spider and the pupae of many bush insects.

2. The Cabbage Tree

This is one of the richest insect habitats that one can find in the bush. Before commencing your search spread the sheets of white paper (or plastic) around the base of the trunk. By carefully parting the leaves you will uncover leaping spiders, and possibly a stick insect. Now search carefully among the dead curled leaves to uncover the cabbage tree moth which, because of its perfect camouflage, is very hard to see. Having exhausted outward appearance shake the tree vigorously and those insects so far hidden will fall onto the white paper to be studied at leisure.

3. Flax Bushes

Though not typical of the forest, flax is an excellent host plant for insects and once again the main requirement is care. Look within the flax leaves separating the flaps as you go. You

are almost sure to find the caterpillar of the flax moth which lives within the leaf. This is a good insect life cycle to follow through in a classroom for fresh flax is easily obtainable and the caterpillar is very hardy. Don't neglect the seed head or stems of the flax flower for they form the home for many insects of the bush.

4. Sunny Places on Branches, Trunks and Leaves

Particularly popular with insects is the foliage of the smaller, more bushy native tree.

By searching amongst the twigs of the lemonwood you may find the Lemonwood caterpillar imitating a twig. Further search amongst the leaves may uncover a stick insect; while if one looks carefully amongst the leaves of a hebe or coprosma, especially in a sunny situation, one is almost sure to find a praying mantis waiting for food. Another good spot for insects is a sunny area surrounded by the scented matipos and lemonwoods.

5. Wood-Inhabiting Insects

Many insects such as the huhu beetle live within the trunks of trees as does the lemonwood borer; but perhaps most unusual is the parasite moth which attacks the climbing plant Muehlenbeckia (pohuehue). This produces a round swelling or gall in the infested twig. Such twigs may be kept in the class for the emergence of the moth (Muehlenbeckia or pohuahue moth).

SPECIAL STUDIES

Muehlenbeckia Galls or Pukuehue Moth

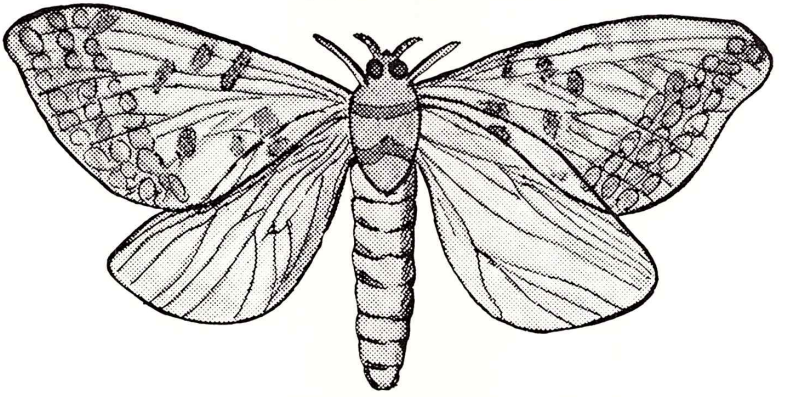
(*See Diagram*)

As far as I can gather there is no written material on this subject and the only information I can vouch for are the drawings which are my own observations. The life cycle has been observed only in part and the gaps have been filled in from numerous sources.

The culprit responsible for the galls or swellings on the stems of pohuehue is a small orange-brown moth with the orange more dominant in the male. The eggs are laid in very early Summer and are usually found imbedded or clustered in the axil of the leaf, the time taken for the eggs to hatch being dependent on the amount of sunlight. On emergence, the caterpillar, which is armed with powerful chewing jaws, begins to feed on the stalk, burrowing into the stem of the plant where leaf and stem join.

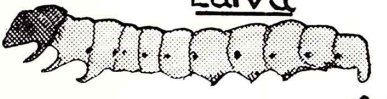
Here it feeds, grows and tunnels creating that curious swelling and thickening of the stem known as a Muehlenbeckia gall. These galls may be two inches long and nearly an inch wide, often being of a striated appearance in a mature gall. As late autumn approaches the caterpillar becomes more torpid and, just before pupation, it bores itself an escape hatch which reaches almost to the exterior of the stem, being separated by a small trapdoor of bark. The caterpillar then turns till its head faces the axil of the

Ghost Moth (adult)



Pupa

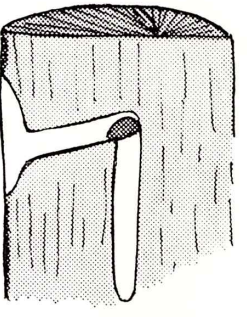
Larva



Note the powerful chewing jaws.

Larval Tunnel

Note the tight fitting trap-door



leaf and in this position it pupates, to pass the winter as a pupa or resting stage. During this stage the whole body of the caterpillar breaks down into juices only to reform around certain growth buds, emerging in spring or early summer as an adult.

The emergence consists only of pushing aside the bark trap door of its escape tunnel and crawling out onto the stem of the plant. Here its wings harden and the moth is able to fly away, to set in motion another cycle of nature.

The Ghost Moth or Puriri Moth

North Island teachers will have little difficulty in identifying this moth which is both large, and of a light green colour tinged with red. The female is not a careful mother but lays about 2000 eggs scattered throughout the bush and often on plants which cannot feed the young caterpillars when they emerge.

On emergence, the caterpillars at once move in search of food plants such as the wineberry, lacebark, manuka, puriri or beech. They then commence to attack the wood of the host plant, creating a small chamber below the level of the bark. There the caterpillar lives on the wood for three or four years but prior to pupation builds itself a tunnel unique in its construction. (See diagram.)

Commencing with the shallow chamber previously mentioned, the caterpillar "eats out" a tunnel, ascending at an angle towards the middle of the trunk or stem. Near the end of this tunnel a second tunnel is commenced which descends perpendicularly for several inches. Within this second chamber, closed by a trapdoor, the larva pupates for a period of about three months from August to November. The trapdoor is exactly the colour of the wood in the top passage and presents the illusion of a single empty burrow.

When about to emerge the pupa showing unusual strength wriggles up the vertical burrow by means of the rows of hairs on its body. Pushing open the trapdoor it crawls by means of tiny hooks to the entrance and pushes through the curtain of bark where the moth emerges.

In all cases the larva and pupa of the male are smaller; and in the adult male the hind wings and body are flushed with red, whereas those of the female are white and green.

HOW TO TAKE BUSH INSECTS WITH A CLASS

The notes on insect haunts will give a good general outline of where one might expect to find the various bush insects but more than this is required. It is in fact necessary that the children have a reasonable knowledge of insect characteristics, and above all it is necessary that the teacher has a good list of references for his own and class use.

References for class teacher:

Miller—*Insects of N.Z.*
Reed—*Native Insects of N.Z.*
Hudson—*Fragment of N.Z. Entomology.*

Sandars—*Insects Book for the pocket.*
D. Beggs—*Nature Study Handbook.*
W. Martin—*N.Z. Nature Study.*

It should also be made clear to the children just why the bush is a good home for insects. In the bush may be found the leaf-eating caterpillars of the various moths, and butterflies, the insects feeding upon nectar, and decaying fruit. Above all are the hunting and parasitic insects which prey upon their fellows.

The Unit study could be as follows:
Introduction—"What is an insect?"
"Where to look in the bush".
Field Trip—"Bush work".
Team Discovery—"Further study from field trip".
Project Work.

A. Introduction

This could take the form of a general talk about insects.

Where they might be found and what you would expect to find. It would be possible, using a flax leaf as a central theme, to have a nature table display of insects and animals found within the flax leaves.

Flax

Insects

Earwigs	Notching caterpillars
Black beetles	Windowing caterpillars
Cockroaches	Leaping spiders

During this introduction you could divide the class into your six groups, each of which might explore a particular area, e.g. a rotting log. The material required for the insect hunt would include screw top jars (ventilated), hand lenses, and plastic sheet.

Before sending the class out to observe insects in the field it is necessary that they have a technique or guide to observation. The following chart would serve in either capacity.

INSECT HUNT

Is it an Insect? or what?	Where found (Habitat)	Colour, camouflage	Size and shape	Other points e.g. what it does when disturbed	Its name

Insect Study

B. Field Trip

The organisation would be virtually the same as that of the tree field trip but a good idea is to take each group to a particular spot within range of vision. In this way you know where each group is working. Fix a meeting place to which all groups return on a given signal.

C. Group Work

It is important that all groups bring back live material for a "team discovery lesson" which could be a more detailed study of one insect, e.g. the Huhu beetle.

Cards would be made out by the teacher and the answers incorporated in the project.

The question card might take following form:

HUHU BEETLE

1. Where was it found?
2. Try and describe its home?
3. What colour is it?
4. Has it a hard body?
5. Are its jaws strong and powerful?
6. What might it eat?
7. Make a drawing of the beetle?

D. Projects

Group study work would follow automatically from this, with each child in the group doing a job, viz.

1 child writing the ecology section, i.e. "Insect Life Under a Log".

3 children writing up the "finds", with the aid of their field notes.

1 child drawing.

1 child to act as editor and leader.

E. Conclusion

The finished product could be bound into a book and as a "follow up" each group could reconstruct a habitat of the area studied for a nature table display.

BIRDS OF THE BUSH AND MAN

Work	Birds	Where found	Food	Special Adaptation
Insect eaters	Rifleman	On tree trunks	Small bark insects	Tiny awl-shaped bill for cracks.
	Morepork	Throughout bush	Moths and night insects	Good night eyes, bifocal vision.
	Kaka	On tree trunks	Cockroaches	Curved claws for tree climbing.
	Waxeye	On branches	Scales, aphids	Small bill, flitting flight.
	Grey warbler	On outer twigs	Aphids	Small body—sharp insect eating bill, fluttering flight.
	Fantail	Open bush	Flies, mosquitoes	Pointed wings for thrust, tail acts as brake.
	Weka Robin	Forest floor	Beetles, insect larvae, spiders	Dipping beak.
Cross Pollination: Nectar-sippers	Tui	Outer bush edge	Kowhai Fuchsia	All have slender curved brush tongue and narrow flattened head for easy entry into a flower. Pollination by pollen collected on head feathers.
	Bellbird	Upper bush layers	Rata	
	Waxeye	On branches and shrubs	Pohutukawa Rewarewa	
Seed dispersers: berry eaters	Pigeon	Forest outskirts though may be deep forest	Miro, tarata, five finger, karaka, coprosmas	Soft bills which do not crush and harm seeds.
	Waxeye	Outskirts	Kaikomako, broadleaf	
	Parakeet	Trunks of trees and branches		

THE VEGETABLE GARDEN

by Joyce Auty

Have you ever considered the wealth of nature study material available at the back door for most of the children in your class? Have you ever wondered how to get your class to continue their studies at home? What better place could you choose than a vegetable garden?—the school one, the home vegetable garden, or the one entered in the children's horticultural club competitions. Consider the scope—not only vegetables but most likely weeds, and a host of friends and foes of the gardener with lessons on inter-relationship, inter-dependence, balance and change, control by man. In fact you can look upon your vegetable garden as the place for finding at least a year's nature study.

A Home for Living Things

Look at the soil. It seems at first glance to hold little that would attract a primary school child. Turn a spadeful over; you may find earthworms, wireworms, grass grubs, beetles and spiders. Begin your study by asking each child to turn over a patch of soil at home and bring one insect or spider he or she has found. Now is your opportunity to begin a wormery; to set up an insect box or jar terrarium as a natural habitat for wireworms and grass grubs; to encourage your class to make a nature map. Get them to draw a plan of the garden and indicate in some way the places where they have made their finds. A class map, a group map or even individual maps, can be used, but the approach depends on the class and the teacher.

Some of your children will no doubt have dug around in places other than the soil: for example, the compost heap. Encourage the children to find as many different animals as they can from the compost, keep them and try to build up their life cycles. Just watching an insect or animal is not enough, especially in the upper classes. To build up a life cycle—especially of a less well known insect—is a challenge even to a Form II class. From the compost heap you may be able to add to your list such things as ground beetles, slaters, housefly, soldier fly and drone fly pupae.

Flats to Let

You have found that the soil is a home for living things. What about all the plants which grow in the soil? Consider the kind of homes which these plants will make for insects and animals.

1. **The Top-Storey Dwellings.** What kinds of plants produce these kinds of homes and what kind of tenants dwell there? Plants which require staking or support of some kind—the legume family, beans and peas, sweet corn, tomatoes, provide the homes. Look at the "home" first. How does it grow?

Watch its growth from seed to producer of seed. As you watch it grow, note the insects and animals which use it as a home. The aphids on the beans, the enemies of the aphids such as ladybird larvae and lacewing larvae, the looper caterpillar on the beans, and of course the bee which visits the flowers. Why are these insects attracted to the plants? How are they adapted to their environment? Are they friends or enemies of man? With what enemies have they to contend? If you can get into the habit of studying plant and animal associations you will find that children will enjoy plant studies much more than they have in the past.

2. **The Ground Floor Apartments.** Consider these in the same way as you considered the "Top Storey Dwellings". Some of them are members of the brassica family such as cabbages. Think again of the insects and animals which use these ground floor apartments as homes. There is the common cabbage white butterfly. Again watch the life cycle. Think of the other insects associated with it: the ichneumon wasp which parasitises the caterpillar, and the parasite of the chrysalis. Extend your studies whenever you can. Do not stick to the old routine of white butterfly. Make that butterfly work for you—let it be a basis for other related studies. Again you will find aphids. Compare them with those you found on the beans. Are they alike? In what ways are they different? Are they parasitised? You will find the empty brown cases of aphids which have been parasitised. What about these cabbage aphids ? Are they all alike or are some winged, some wingless? What enemies have they? What happens when their Ground Floor Apartment becomes over-crowded?

3. **The Underground Tenements.** Your studies have taken you below the ground again. You have studied some of the insects and animals which live there. Find out about the ones which use the root family as hosts. The carrot rust fly which makes holes in carrots, parsnips, and celery. Try to find the eggs near the young plants, examine the creamy white legless maggots. Find out where the pupa rests and how long it takes before it becomes a fly.

   In the roots you will find millipedes and wireworms. The life cycle of the wireworm can prove an interesting study. Keep some in a suitably set up habitat in the classroom and watch them turn finally into the click beetles. The children will know these beetles as "skipjacks" which turn over with a click when placed on their backs. How many of the children in your class would previously have associated them with the destructive wireworm which is their larvae. Cereals, brassicas, potatoes, carrots, lettuce and strawberries can all suffer attack by wireworms.

Incorporate into your studies the means of camouflage used by all these animals. Study the adaptation to environment and get your groups to consider which animal is best adapted to its environment. At Forms I and II level, this subject can be a good topic for debate, and what good nature study and oral expression you can get from it!

Interdependence

You have already studied to some extent the way in which plants supply food for insects and the smaller animals. In fact these insects depend upon plants. Look now at the way in which plants depend upon insects. Two good plants to use for this study are the pumpkin and bean. The pumpkin has a large conspicuous flower. Why? It has male and female flowers. Can you distinguish male from female? How is it pollinated then? What insects aid it? You will find good articles in the Journals of Agriculture on pollination of both beans and pumpkins.

Without the insects some plants would not become fertilised and so would not produce seed. What precautions do the plants take to attract insects to them? Are they brightly coloured, daytime flowers, or are they heavily scented, inconspicuous flowers which attract night-flying insects by their smell? It is a good idea to choose one central point to begin your plant and insect study —for example, aphids.

An Enemy—the Aphis

Aphids derive food by piercing the plant tissues with their mouths and subsequently sucking the sap.

In the autumn there are developed in the aphid colonies on carrot and parsnip, special winged forms which fly to adjacent willows. On willows there are produced the wingless egg-laying females. Winged males appear at the same time and mate with the egg-laying females which lay eggs in the axils of buds. Eggs are shining black and there may be several in each bud axil of an infested willow twig. The egg is dormant throughout the winter but in the following spring, hatch at the same time as the willow buds burst so that a succulent food supply is right at hand. After feeding and breeding on willow foliage for a time, colonies produce winged forms which migrate to the parsnips and carrots. Migration takes place about November after which the aphids increase in number and do most damage after Christmas. On carrots, aphids produce living young, and pass through several generations until autumn when winged "return migrants" return to willows to recommence the cycle.

The Black Bean Aphid is another common garden pest. It is mostly dull black although part of the antennae and legs appear to be lighter in colour. They are common on all types of beans, especially broad beans. They cluster on succulent terminal parts of the stem and shoots, causing deformation of leaves and in

severe infestations, stunting and wilting. Blowflies hover round infested broad beans and feed on the honey dew exuded by the insects.

Cruciferous crops generally are attacked by another aphid, a green one (Myzus persicae). Cabbage, turnips, sprouts, wild mustard and shepherd's purse, all suffer attack. The aphids injure the leaf and seed stalks and feed on the upper and lower surfaces of leaves. The colonies are small at first causing leaves to curl, and these folds form shelters for developing colonies. The colonies appear in January and February, often on isolated plants. In a few weeks, they will have spread to neighbouring plants unless checked. Plants which are attacked give off a characteristic odour. Long, dry seasons are favourable to aphid colonies and they thrive best in a humid atmosphere. Often they will live on winter greens but their growth is retarded in winter by the cold. When spring arrives the winged aphids are produced and these fly away to start new colonies on new crops.

The typical life history of any species of aphid is that they winter on some perennial plant as fertilised eggs. Some winter on dead remnants of annual vegetables. Eggs are small, ovate, blackish objects, glued on their sides, generally to the stems of plants or in crevices about the buds.

When the weather becomes warm enough, small nymphs hatch from eggs which grow quickly to full size but never get wings. These aphids are called "stem-mothers" because they start a great colony of aphids produced during the season.

Friends—the Ichneumon Wasp and the Lacewing

All the ichneumons play an important part in the destruction of insect pests. Some species are external parasites, most of them live within the bodies of their victims, within which they pass their entire larval existence. The ichneumons which parasitise aphids are of the family, Braconidae and are commonly known as Aphidius.

Examine colonies of aphids and you are almost certain to find the dried bodies of dead ones in which the abdomen is more or less spherical and looks very distended. These bodies remain clinging to leaves in the position in which the insects were when they died. From each one of these dead aphids emerges an Aphidius. The parasite in emerging cuts a very regular circular lid in the dorsal wall of the abdomen of its host. When the adult parasite has selected an aphid in which to lay an egg, she stands with her head towards it, and bending her abdomen under her thorax between her legs, she darts her ovipositor forward into the body of the aphid. The eggs of the parasite undergo metamorphosis in dried skins of aphids and do not spin cocoons.

Compare the action of the braconid with that of the ichneumon which parasitises the caterpillar of the white butterfly.

Another enemy of the aphid is the lacewing. The larvae of the lacewings are always hungry and often referred to as aphis lions. They will eat any insect which they can overpower.

When the aphis lion is full grown, it rolls itself into a little ball and weaves a small, white glistening cocoon around itself. After a while, a circular lid is made in the cocoon and out of this, emerges a dainty, little insect with delicately veined wings, slender antennae and large eyes. Look at one of these dainty creatures under a lens and you will be struck by the similarity of the shape of its head to the head of the praying mantid.

The eggs are laid singly. If they were laid in a batch on a leaf, the first hatched would probably eat the rest. The mouth parts of the aphis lions are very unusual. On the lower side of the long mandibles there is a furrow and in this furrow the long, slender maxilla fits. In this way the mandible and maxilla of each side form a tube through which the blood of the prey can be drawn. This explains why an aphis lion holds its prey on the tips of its long jaws, while sucking its blood.

The Slums

We have studied the dwellings and the inmates, now let us look at the garden weeds—the unwanted homes of many insects. Unwanted by the gardener but quite acceptable to the insects. In this category are many plants useful for nature study work. Amongst them are twitch with its strong rooting system, convolvulus with its rooting and climbing habit, milk weed, groundsel and shepherd's purse. Many others occur and can be studied as they are brought forward for identification.

Study the growth habits, and from this deduce the means of combating them. Think particularly of adaptations for particular purposes, and of methods of reproduction. Try to trace the history of each plant. This is a good project for upper classes and will lead the children into some good reading.

Origins

Similarly the plants of the vegetable garden can provide interesting history as very few are native English species. The potato comes from the Andes, so by way of Mexico, does the tomato; beans from Mexico and celery from Italy. Cabbage is a native of Europe. In the wild state it is an open, rose-shaped plant in numerous shades of blue-green, sometimes touched with purple, the leaves frilled, but without the dense head of our garden cabbages. Brussels sprouts and cauliflowers are both mutants of the cabbage. Carrots grow wild in England but garden carrots were introduced by the Anglo-Saxons from Germany. What of the native New Zealand vegetables or the vegetables the Maoris brought with them? What a good opportunity to link your nature study with social studies!

Birds

Do not forget your bird visitors to the garden. The thrushes, blackbirds, starlings and sparrows particularly. Are they friends or foes? Much has already been written about birds and in previous bulletins you will find a good deal of information useful to your study of birds.

Link with the Nature Table

I firmly believe that to take successful Nature Study you must use your nature table to its best advantage. Try always either to link your lessons with the display or else to make the table a follow-up—or both. It is not a burden if you use a monitor or group system and give them guiding instructions each week . It is easier for forty children to provide material for both lessons and table, than it is for you to do so.

A Seasonal Plan

Here is a brief plan as a suggestion for your nature table based on your series of lessons on the Vegetable Garden.

Term 1

1. **Know Your Garden Insects.** Get children to bring garden insects for study at school and get them to watch insects in the garden at home. Encourage them to build up life cycles wherever possible.
2. **Plant Families.** Display plants which belong to the same family. Include cultivated plants and weeds in each family wherever possible.
3. **Garden Friends and Foes.** Rather a general heading but it provides a good scope for the latter part of the first term. It can include plants, insects, animals and birds.

Term 2

1. **Over-wintering Plants.** The method of over-wintering employed by both weeds and vegetables. Cabbages, beans, shepherd's purse, all come into this category. Autumn sowing of crops can also be a basis here.
2. **Indoor Gardens.** Break away from the old idea of a carrot top in a saucer and a bean in a jam jar. Make your indoor gardens attractive. Use a flattish dish or a deep enamel plate. Put gravel in the bottom. Set carrot tops, parsnip tops, beetroot tops into the gravel. Surround with moss and keep well-watered. A bit of ivy will add more beauty to it. Try experiments with germinating seeds. Do they need—air, water, light? Try growing seedling trees from fruit gathered in the autumn.

3. **Our Garden Plan.** Now is the time to plan your garden for the spring. What plants grow when? What about crop rotation? Manuring? A model garden can be built up in tray or a map can be built up as the class decide what should be planted, where and when.

Term 3

1. **Make a Start Inside.** Plant seeds in boxes ready for transplanting. Gardening guides or the local nursery will give you hints on how seed boxes should be prepared and how seedlings should be cared for. I believe that this kind of instruction should be given in Forms I and II. It is seldom given later, and what a help it can be later to either boy or girl!

2. **Know your Garden Seeds and Plants.** This can be a useful opportunity for children to learn which seed grows into what plant, and what each seedling looks like. Weeds, too, should be included in this, so that children become accustomed to distinguishing, wherever possible, seedling weeds from seedling cultivated plants.

3. **Garden Diary.** From both a nature study and an English point of view, a diary is an asset. You will have heard much about nature table diaries already, but a garden diary, properly kept, will probably be one of those school books which is not thrown away as soon as school is over. A well-kept garden diary can become a useful reference book.

Here is a list of books which will aid you in your studies:

An Insect Book for the Pocket. Edmund Sandars. 18/9.

Nature Study Handbook. D. Beggs.

Nature Study (Pacific Island). R. R. V. Blanc. 25/-.

The School Garden, Books 1, 2, 3. J. E. Hancock. (Macmillan & Co. Ltd.) 10/- each.

Yates or Brett's **Gardening Guide.**

Plant Protection in New Zealand. Govt. Printer (Reference Book).

Weeds of New Zealand. Hilgendorf.

The Jungle in the Backyard. I. W. T. Munro. (Primary School Bulletin).

THE FARM

The Nature Study Third Year Group

Living on a Farm:

Dairy farming is part of New Zealand's way of life. Many a school is set in the green landscape of ryegrass pasture and dairy cows. If education is to be based on environment, and if rural schools are to be more than poor miniatures of the better equipped institutions of the city, then these rich surroundings must contribute a major part to the life and teaching of the school. City schools themselves will find their social studies and nature study programmes enriched by visits to farms, which are nowhere far distant. Indeed, such visits are necessary to fill out the picture of New Zealand at work which social studies programmes attempt to present.

For most teachers, two difficulties become apparent when an attempt is made to organise these visits. One arises from lack of knowledge of farms, the other from the problem of organising a group for full participation in an observational programme. The purpose of these articles is to assist teachers with these difficulties.

Planning a Farm Study Unit

A farm study provides a fine opportunity for planning on a wide basis, and, indeed, over a long period. These articles could well provide material for a year's work; but it must always be understood that what is attempted will depend on the enthusiasm of teacher and class. The work should be abandoned when interest flags. Again, for lower classes, just to visit the farm say once in each term and allow the children to "stand and stare", to touch, to smell, to absorb experiences will probably be sufficient; provided it is realised that all of these new experiences will produce excitement and stimulus and many a talking point for good expression in the classroom. A model farm, built up with soil in a tray or polythene enclosure and planted to represent paddocks, makes a fine indoor teaching unit for an infant classroom.

For upper classes much more can be attempted. Key ideas in planning will be:

—*farming as a way of life,* both in New Zealand's past and now.

—*the farm as an area study*, with interesting plants and animals, forming a community of living things.

—*the farm as a laboratory of science*: modern science has come to the farmer's aid and produced a spectacular revolution in farming methods.

—*the farm unit as a unit also in expression*, providing situations and opportunities for a vast amount of well-stimulated writing and drawing, in terms which the rural child, at least, is well able to comprehend.

Some Key Methods

The Farm Trip or Visit will be discussed more fully, as providing the focal point about which the whole revolves.

The Nature Table, set up for a term or at convenient intervals, to provide an indoor diorama of what is under review outside on the farm. It will be best if the table is set up by groups studying the various aspects of the farm as some record and expression of what they have seen and found. Above it should be a map of the farm to which the exhibits are referred by arrow or string.

The Home Project is more particularly for country children; some enthusiastic pupils will be commissioned by the whole class to find out over a period things which cannot be observed on a single visit—frequently problems concerning the habits of the animals, or the routines of the farm.

The Investigating Group, a panel of children who have evinced interest in a particular facet of the study and have agreed, or been appointed by the class, to observe, read, record and report on this subject. On a visit, they may be responsible for handling the class at a particular station, for example at the milking shed or piggery. The units numbered 1 to 5 in these articles have been devised for investigation by such class groups. Indeed, this whole unit has been planned on the basis of such group study.

Introducing the Unit. It will be best if the teacher approaches the class in such terms as to enlist their active co-operation and win their ready involvement in what promises to be an exciting bit of exploration. Country children are frequently made to feel that the best is all to be had in the cities. The live dramas of the farm are overlooked, or lost in the drudgery of farm tasks. By linking the animals, plants, machines and techniques of the farm with the pursuits of the school, the skilful teacher can give farm children a new and undreamt-of opportunity to contribute worthwhile knowledge to the school, and so win their enthusiastic co-operation. His main weapon may well be his lack of expert knowledge, with a plain reliance on the exploratory method. The "you teach me about the farm" approach will seldom fail to bring new knowledge to both teacher and class.

When interest and a keen desire to participate have been achieved, joint planning emerges as the next important undertaking. A farm must be selected, perhaps "adopted" for the year. Discussion as to what is the most suitable sort of farm will bring the class to a more definite understanding of objectives in terms of what we want to Find Out. These may be listed on the blackboard and areas of special interest selected by different groups (see Units 1 to 5). Visits will have to be arranged, and letters written. The method of employing the nature table as a base of operations will need discussion, and some monitor system will have to be worked out. The form in which Our Story of a Farm is to be portrayed

will require thought and the pooling of suggestions from the class. A good method is to build up a booklet to which each group contributes an illustrated chapter.

With the reportings from the different groups, the expression incidental to planning, the various writings which farm-based experiences will stimulate, and, finally, the editing and "publishing" of a book which all may read, there should come incentive for a unit in expression which the class can face with some anticipation. The book itself can be shared with other classes, with farmers who have co-operated and with parents.

Organising the Visits

If possible, plan for an observational visit each term, preceded by an introductory look over the farm, as a class, "to get our bearings".

Some preliminaries will require attention—making arrangements with the farmer, enquiries regarding transport and toilet facilities, suitable clothing, first aid kit, obtaining parents' permission, and finding people who can help us in various ways. Questions of farm courtesy, such as the shutting of gates, avoiding of loud-mouthed comparisons between this farm and that, proper consideration for animals and for fences, are important if the good will of the farm owner is to be maintained. How to approach and handle the farm animals—always stopping at a considerable distance from them, to observe their initial reactions—will need discussion.

On the First Visit, perhaps in time to observe some late harvesting, the aim should be to map the farm roughly, to find the names of the paddocks, to identify features and places of special interest, and to allocate areas or topics (see Units 1 to 5) to the groups for observation and special reports . It will be desirable to have the farmer himself tell the class something about the farm and its daily routine of duties. Better than to have this in one extended talk, is to arrange it in the form of a tour to places of interest—milking shed, the herd, the hay barn or silage pit, the turnip paddock, the implement shed. Key questions, the answers to which effect future planning, can be worked out for each place, e.g. "What happens here in winter? What is the best time to visit here?" Arrangements for mapping would include ascertaining the areas of paddocks, finding out where north lies, making a rough sketch and showing it to the farmer for correction, marking in places of special interest, and perhaps stepping out some distances.

The tasks planned for each visit, and for the various groups, should be discussed prior to this visit, if possible, so that the children may talk their special interests over with the farmer and make any necessary arrangements with him for project work.

The Second Visit will be preceded by a considerable amount of preparation by the groups in terms of "What we want to find out on our next visit." This visit will probably occur during the latter part of the first term. What will be in season at that time will have been ascertained from the farmer on the previous visit, so that questions can now be worked out (some are provided in the text), on cards, or in group field notebooks, to guide the groups in their observations. This will require reading and discussion, so that there may be some background understanding of grasses, animals, the science of the farm, and other topics to be observed. Preparation will also be made for nature table exhibits by the groups and for returning various things to the classroom for this purpose; for filling in the farm map with further detail; and for language, art, social studies and nature study work that will follow the visit. If a later visit is planned for several classes, or for the whole school, this visit and the next should be undertaken by a smaller selected group, or senior class, whose job it will be to show the others over their various areas at a later date. On the visit itself, a good method will be for the teacher to conduct the whole class around the various stations, dropping the groups in turn at their particular stations with some explanation, on the spot, of what is required of them. The groups then work on their own topics, guided by workcards, and the teacher—perhaps the farmer also—visits them in turn to assist and direct their observations. This visit will result in the accumulation of a large amount of observational and inspirational material which the groups can put into shape, say, as illustrated book chapters, back at school. The task of exhibiting their work and reporting on it to the rest of the class will provide a real situation in expression in the best spirit of the new English syllabus.

The Third Visit, if undertaken in the mid-term, will provide a new view of farm happenings at the stations in the winter season. Important topics would be winter food and shelter, the overwintering of insects, weeds and birds, and the identification of pasture plants, known on the first visits from their seed heads but now from leaf alone. The farmer, with more time at his disposal, may talk to the class about rural life, about the history of farming in the district, about the way science assists, and about special problems which have emerged from the observations of previous trips. The nature table will show facets of farm life in winter set up by each group.

The Last Visit, in the third term, will have the new interest of spring events. A large amount of attention might be paid to the young animals, linking this with the Boys' and Girls' Club work prominent in this term, and there may be a talk from the farmer on rearing pet calves. The groups, now much at home in their special interests, may take the whole class, or school, to their stations in turn, telling them what they have discovered and giving

them things to look for or find out. Various children may have special hobbies, such as the care and training of dogs or horses, which can engage the attention of the class, the child taking the part of "teacher" or "expert". This visit will be followed by the usual nature table excerpts, this time covering spring happenings on our farm, by final reports from the groups, and by activity on the part of the editorial committee which will result in the publishing, and sharing, of Our Book—A Year on a Farm.

If the whole is tackled as a comprehensive project for the study of a New Zealand landscape, it will result in an accumulation of experiences sufficient to stimulate and give point to much of the classroom work for a great part of the year.

INHABITANTS OF THE FARM 1 — ITS PLANTS

UNIT 1 THE PASTURES

The common term which children (and all too many adults) use in describing the plant cover of a field is "grass", an all inclusive term which frequently means very little. A better understanding of the plants on which we depend for our sustenance and livelihood will be had if we distinguish the inhabitants of green pastures as grasses, clovers and weeds, the three races making a community. The community is vigorous and successful if it is built upon the sound principles of *Inter-relationship and Inter-dependence* (see Core headings in the 1948 Syllabus). There is civil strife and confusion *The Struggle to Survive* (again see the Core headings) becomes the ruling principle as when weeds become too prevalent.

The Plant Community of the Pasture

A. **The Ryegrass-Clover Team.**

Ryegrass and white clover are the two main plants upon which New Zealand's economy has been built. The two make a fine team in the service of the farmer. Each is able to contribute what the other lacks :

1. Clover, equipped with rooting stems, fills in the spaces between the more tufted, upright ryegrass.
2. Clover, with bacterial nodules on its roots, can draw nitrogen from the air and so enrich the soil for ryegrass, a high fertility pasture grass.
3. The nodule bacteria require warmth and a well-aerated soil for this work of nitrate production, so that clover thrives in summer and autumn. Ryegrass keeps the pasture community going in winter and early spring. (See *Seasonal Change* in the Core.)

4. Clover provides lush, rich food, high in protein content, but conducive to bloat and digestive disorder. This is nicely balanced by the greater cellulose content of ryegrass.

Group Projects:

1. Set up a ryegrass-clover paddock in miniature on the nature table by digging out a good sod, fitting it into a deep enamel oven dish on the nature table, and watering it regularly. "Mow" it with scissors and study the growth of the plants during, say, the third term.
2. Keep a diary of the growth of the different plants in the pasture through the year and record their flowering times. This can be done by a quadrat, i.e. marking off a yard square and drawing or recording its inhabitants each term (see Nature Study Bulletin, May, 1959. Places to Explore: Grassland).

B. **The Other Grasses.** There are other important, but junior partners in the pasture community, each with a special part to play.

Such grasses as cocksfoot, timothy and foxtail are erect growers and very suitable for providing the lush, rank growth of a hayfield. Because of this, they are often seen on ungrazed roadsides.

Many dairy farms have damp, boggy areas where cows love to wade knee or ankle deep in search of succulent food. Kneed foxtail, creeping bent or floating sweetgrass are specially adapted for such conditions.

In the far north, paspalum, a sub-tropical grass, is so suited to the warm conditions that it often takes complete possession.

Group Projects:

1. Select different pastures, some well-grazed, some closed for hay, some boggy, others dry, and set them up in soup plates or oven dishes on the nature table, naming the plants and drawing them. Separate out a plant of each, and place them in separate vessels (soup plates for low growers, jars for erect growers) to study their method of growth. How is this suited to the places they live in?
2. Make a grass collection by pressing grasses between newspaper as they flower.

C. **Rogues in the Pasture: The Weeds.**

Weeds are well adapted plants because they can grow almost anywhere, without any help. They are therefore good topics for study under the *Adaptation* heading of the syllabus. The most common dairyfarm weeds are those which prefer moist conditions. Again, select weeds from the different places enumerated in the last section, and compare them by studying their adaptation to their several haunts.

Projects:

1. Dig up weeds in a sod of soil to fit neatly into soup plates on the nature table, and display them as they come into flower.
2. Make a weed book by pressing and mounting them, either in their families (see Hilgendorf: Weeds of New Zealand) or in their communities or haunts. A collection of this nature can start with the dairy farm and carry over to weeds of the district.
3. Organise a Know Your Weeds Week with displays and quiz.

SOME OF THE MEMBERS OF THE COMMUNITY

White Clover

Clover is a quick summer grower, being useful both for grazing and haymaking. All members of the clover family have a leaf which is made up of three equally stalked leaflets.

1. The flower is white
2. Hairless leaves and stems
3. Has a stolon (creeping overground stem)
4. The leaflets are heart-shaped or elliptical, toothed

Once a pasture of white clover is established the plant reproduces itself by rooting stolons and by seed.

The reason why white clover is able to withstand drought is because of its dual rooting system:

1. Tap root going deeply for moisture.
2. Adventitious roots arising from the nodes, making the rooting system very extensive.

Relation to Bees. White clover is self sterile, so that it needs to be cross pollinated, the usual agent being the hive bee. The bee is able to distinguish between fertilized and unfertilized florets, as the fertilized florets usually bend down, leaving the unfertilized florets of the flower head sticking up.

Red Clover

This differs from white clover in that—

1. Flowers are pink or mauve.
2. There is no stolon.
3. Leaf margin is smooth.
4. Plant may be hairy.
5. Flower head is borne on a short stalk and below it there are two leaves.

There are two types of red clover which you may find in pasture—Montgomery Red and Broad Red, the latter flowering first in mid-summer and the former later in autumn.

Relationship to Bees. Red clover is self sterile as the pollen is ripe before the stigma is ready to receive it. In nature, cross pollination is carried out chiefly by bees. With the red clover the floret is very long so that to get the nectar from the bottom of the floret the bee must have a long tongue. Bumble bees, particularly those of the long-tongued species, are therefore the main pollinating agents.

When red clover was first introduced into New Zealand it failed to set seed as there were no long-tongued bumble bees for pollination. Live bumble bees were therefore imported from England and the clover crop was then ensured. (See Nature Study Bulletin for article on Bumble Bees, January and May, 1960).

Relatives of Clover on the Farm

As well as white and red clover, there are a number of other members of the Legume Family on the farm. Some of these are:

1. *Lucerne.* This is used widely for haymaking, giving three to five cuts a year. The plant will grow up to three feet high and the root may be twice this length. The flower is purplish blue in colour. This plant is used extensively in South America where it is called alfalfa. Lucerne is a medick, with a longer stalk on the end leaflet.

2. *Black Medick* and *Burr Clover* grow in waste places. They are closely related to Lucerne, having a stalked end leaflet and similar fruits and flowers.

3. *Birdsfoot Trefoil* or Latus major grows in damp places. It has 5 leaflets (3 + 2 stipules), and pods arranged like a bird's toes. Again not a true clover.

4. *Strawberry Clover* is a true clover, similar to white clover in growth, having a prostrate stem and a terminal flower head on a long stalk. Below the flower is a collection of thin papery bracts. The ripe flower head is a pink colour and resembles a strawberry. This clover likes a sandy soil and is therefore found in coastal areas. It was used in the Napier district in reclaiming salt marsh land for pasture.

Work for the Clover Group

Set up a clover sward along with the grasses as a central exhibit and along with this the various types of clovers, with their differences pointed out to the children. At the end of the week hold an identification quiz.

Questions:

1. How many leaflets on a clover leaf? Are their stalks all the same length?

2. Examine the clover flower. Is it a single unit, or is it made up of florets?
3. What garden flowers do the individual florets resemble?
4. What insects visit the clovers?
5. Where does the insect probe for nectar?
6. Tie bags of cheesecloth over some clover heads and see if they set seed.
7. Examine the roots of some plants. What can you see on the roots when you wash them? (bacterial nodules).
8. What clover-like plants can you find? Are they true clovers, medicks or lotuses? (See Hilgendorf: Pasture Plants and Pastures.)

The Ryegrasses

These are New Zealand's most important and popular grasses, producing a large amount of food which is extremely palatable and has a high nutritive value. Most members of this species grow rapidly in their younger stages, thriving well under the tramping of stock, and indeed, under the feet of children in the school playing field. Ryegrass will be found growing near the metal of a road, while cocksfoot grows nearer the fence line, where tramping is less severe. Ryegrass will remain green throughout the winter and starts new growth early in spring.

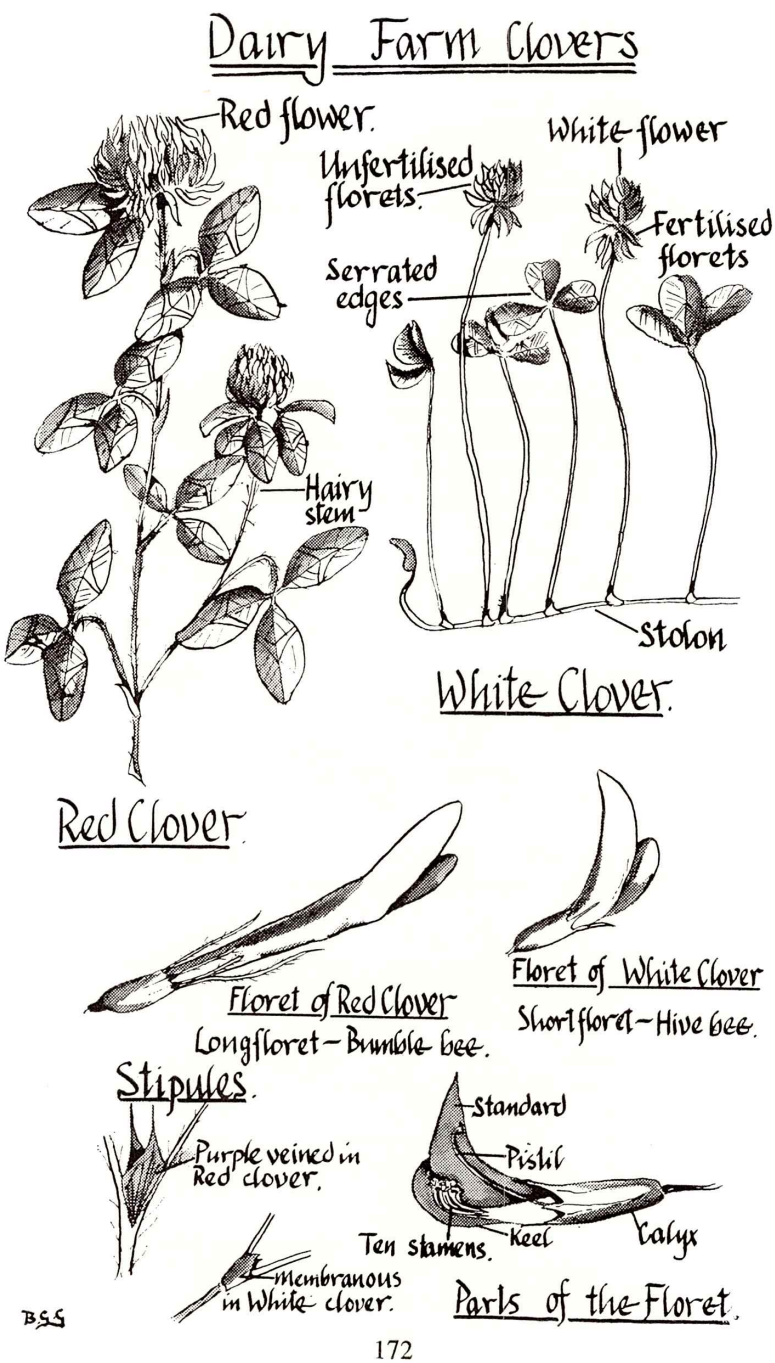
The three main types of ryegrass are—perennial, Italian and short rotation.

1. **Perennial Ryegrass:**
   1. Medium size.
   2. Distinctly red at the bottom of the sheath, just below where it enters the ground.
   3. Ligule short and cut square.
   4. Small clasping ears.
   5. Upper surface of blade is ridged, lower being shiny.
   6. Sheath is compressed in an oval shape just under the leaves.

Perennial ryegrass will give a good strong pasture in the first and second years of growth, and continue to flourish without resowing for many years. This makes it an admirable grass for North Island dairy pastures which are seldom ploughed.

2. **Italian Ryegrass:**

This is found mainly on cropping or mixed farms rather than on straight dairy farms. It has a more vigorous growth than perennial ryegrass. Its features are similar to those of perennial except that the sheath is round instead of oval, just under the leaf blade. Italian ryegrass has awns on the flowers (hair-like projections), whereas perennial is awnless. Italian pasture is renowned for its food producing capabilities, but the pasture will last for only one or two years, unless on very heavy ground where it may become almost permanent. Italian rye is a very good haymaking grass.


Dairy Farm Clovers
Red flower.
Hairy stem
Red Clover.
White flower
Unfertilised florets.
Fertilised florets
Serrated edges
Stolon
White Clover.
Floret of Red Clover
Long floret – Bumble bee.
Floret of White Clover
Short floret – Hive bee.
Stipules.
Purple veined in Red clover.
Membranous in White clover.
Standard
Pistil
Keel
Calyx
Ten stamens.
Parts of the Floret.
BSS

3. **Short Rotation Ryegrass:**

A grass, commonly found in crop areas, which was developed by the D.S.I.R. by crossing perennial with Italian ryegrass so that a grass evolved which had the good qualities of both types: the high palatability and early growth of Italian as well as a longer life of three or four years, derived from perennial. In appearance the plant is similar to Italian, having broad fleshy leaves and seeds which are mostly awned.

Floating Sweet Grass:

The broad light green leaves of this plant can be seen floating on the surface of any pond or area of still water. Growth can be so prolific that the water surface is often hidden. The leaf has parallel sides to near the tip, where it quickly converges to a point to give a canoe-shaped appearance to the leaf blade. This is an extremely palatable grass and cows will walk into water up to their stomachs in order to eat it. In many areas this grass is regarded as a weed as it often blocks water courses.

Yorkshire Fog:

Although an unpalatable grass, cattle will eat Fog fairly readily. As is the case with floating sweet grass, it likes damp or moist conditions and is often found as the dominant grass in wetter and older pastures.

Fog can be distinguished by the velvety hairs which cover the blade and sheath and by the red and white "peppermint" bands which are found at the bottom of the sheath.

Meadow Foxtail:

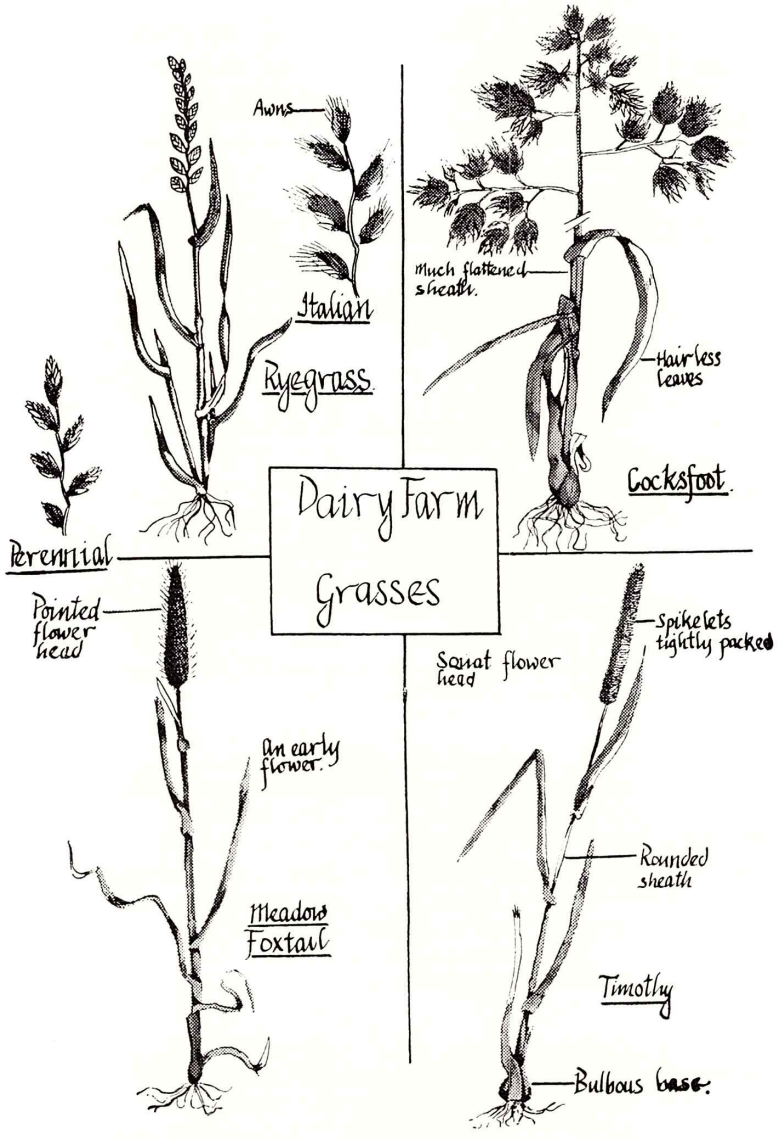
Like twitch, foxtail has an underground stem (rhizome) which after travelling along under the ground for two or three inches, sends up a hairless bluey-green leaf. The sheaf is round and ligule short and obtuse. On a warm day the leaf can be seen to curl up.

Foxtail is a notable grass in its permanence and palatability, which increases under grazing. Foxtail will grow only in land where there is ample moisture without waterlogging. A relative of meadow foxtail is kneed foxtail in which the stem creeps along the ground and is then kneed or bent, to grow upwards.

Cocksfoot:

This is a perennial grass which will produce good feed on all but the wettest and lowest fertility soils. It is a bushy grass, making the greater part of its growth during the summer months. It will be found growing in the grass sward in areas which are too dry for ryegrass.

1. Hairless grass, blue green.
2. Sheath compressed to give almost a cutting edge.
3. Ligule pointed.
4. Blade tapers gradually to a tip.


Awns
Italian
Ryegrass
Much flattened sheath.
Hairless leaves
Cocksfoot
Perennial
Dairy Farm Grasses
Pointed flower head
An early flower.
Meadow Foxtail
Spikelets tightly packed
Squat flower head
Rounded sheath
Timothy
Bulbous base.

Timothy:

Timothy is a very palatable grass, similar in colour and general appearance to cocksfoot.

1. Leaves with blue-ish tinge.
2. Bulb-like swelling at the base of the leaf sheath, underground and just above the rot.
3. Leaf Sheath round.
4. Ligule conspicuous.

Timothy thrives best on heavy lands and will succeed on wet clay where other grasses fail.

Work for the Grasses Group

1. Display different grasses side by side on the nature table, labelling the points important in identification. At the end of the week organise a quiz. A Know Your Grasses week will be a popular innovation in country districts.
2. Follow this, say in the spring term, with a Grass of the Week series, placing the grasses out as they flower.
3. Have a maize or sweet corn plant on the table to show the parts of a grass family plant.
4. Display a large grass plant (prairie grass is suitable) in flower with a large sketch to show the parts of the flower.
5. Have a plant with creeping underground stems (e.g. twitch) and one with creeping overground stems (e.g. creeping bent) for comparison.

N.B. Refer to the articles on Grasses by C. Burrows in this year's bulletins.

The Buttercups

There are many different types of buttercup, the most common being field buttercup, creeping buttercup, hairy buttercup and the celery-leaved buttercup. Most of the above types can be found growing in damp pastures and ditches from Auckland to Southland. The buttercup is an annual, the leaves are bright, shiny and usually three-lobed; the flower is always yellow. The growth form varies among species from an erect plant to a creeper. (See Nature Study Handbook.)

The Mint Family Weeds

Selfheal is a weed abundant in damp or waste places on the dairy farm. It is a perennial with a creeping rhizome and trailing stems from four to twelve inches long so that it can form a dense mat which chokes all other vegetation. The flower is a purple, terminal spike about two inches long.

Pennyroyal is extremely common in the Auckland district, where it is very hard to control on account of its creeping rhizome and its much branched, trailing stem. The flowers are bunched along the stem and pale blue in colour. Cattle will eat pennyroyal but they have been known to develop a peculiar cough after feeding on it, and it taints their milk.

The Thistles

Californian and Scotch Thistles. These are very common plants in neglected pasture. Californian thistle, if left to spread by means of its strong underground stem, will soon over-run the paddock. (See Nature Study Handbook, p. 60.)

Questions on Weeds:

1. Look at the root of the weed—is it the same as that of a grass?
2. Is the stem erect, sprawling, or climbing?
3. Have the weeds been eaten by the cattle?
4. Group the weeds according to the colour of their flowers.
5. How do you think the weed seeds are scattered?
6. How do you think the weeds are harmful to the pasture?
7. What insects are attracted to different weeds? What do you think attracts them, and what do they do for the weeds?

LUCERNE

The name "lucerne" originates from the French "luzerne", but in America the name "alfalfa" is used. This is derived from an Arabian word meaning "the best fodder". Sometimes it is called "purple medic" from the colour of the flower and the group name, medick. This helps to distinguish it from one of its close relatives, the "black medic" or yellow trefoil.

Explorers have found in Central Asia lucerne that must have grown wild for countless ages. The earliest reference to it is in the Bible. The Greeks and Romans knew it, the Romans cultivating it at great labour and expense. So it spreads to Spain, France and Germany, reaching England about 1650 A.D.

A Dry Land Plant

From Persia and Australia it is no great step to the dry lands of Otago and Marlborough. One of the reasons for lucerne's successful growth in these dry areas is the very long coarse taproot with numerous side branches which enables it to reach moisture at a considerable depth.

The names of its various strains indicate lucerne's climatic preferences. Most of them are natural selections suitable for various climates: Marlborough; Hunter River (from the same district in New South Wales); Peruvian and Arabian; Provence (commonly grown in South West France); and Yellow-flowered Lucerne.

Lucerne is largely used as a fodder crop and made into hay or silage. It is a good source of Vitamin A and B.

Legumes and Medicks

Lucerne is a member of the Legume family and this family always wears its traditional clothes: butterfly-like flowers, seeds in pods, leaves made up of leaflets, and nodules on the roots. Many of the plants in the garden at home—sweet peas, lupins and green peas—belong to this same family. Within the family there is a group of plants known as the medics, and it is to this group that lucerne belongs. These plants have trifoliate leaves with a stalked end leaflet and projecting midribs. A good idea is to compare lucerne with its cousins: black medic, burr clover, spotted burr clover. These are common weeds.

Tripping the Flower

In the lucerne flower the stamens and pistil are enclosed within the keel. They will remain like this, and the bud will eventually fall off unless the flower is opened by some outside stimulus. This process is known as tripping and it may be demonstrated by (a) poking a pencil point into the throat of the corolla, (b) striking the flower sharply, or (c) by warming it with the glowing end of a cigarette. Out in the field tripping is caused mainly by the bumble bee or by hot winds. If you have the opportunity, watch a bumble bee in a lucerne paddock. It buzzes practically from flower to flower collecting nectar and tripping the flower by pressing the throat of the corolla. As it does this, the under part of the pollen covered abdomen is struck by the stigma which thus collects pollen from another flower, effecting cross-pollination. At the same time the anthers shower pollen on to the bumble bee's body; this will in turn cross-pollinate another flower.

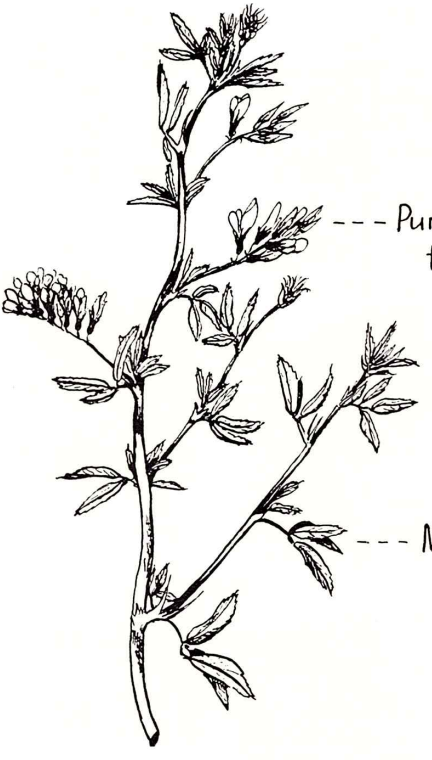
Honey bees are far more numerous than the bumble bee, but they gather nectar by inserting the tongue at the base of the corolla and so rarely trip the flowers, except by accident. However, they do gather pollen on their bodies from the tripped flowers and scatter it on the standards of the untripped flowers. Then when the flower is tripped by some other agency, the stigma hits the standard and often cross-pollination occurs.

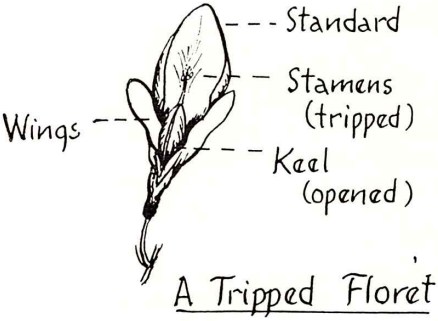
Nitrogen Factories

Like most legumes, lucerne plants obtain their nitrogen supplies from the air through wart-like growths, or nodules, on the roots. The nodules contain bacteria which convert nitrogen of the soil into nitrates which are assimilated by the plant. In return, the plant supplies the bacteria with the carbohydrate requirements. If the bacteria are of a poor strain or absent, the plants are yellow and stunted, eventually dying.

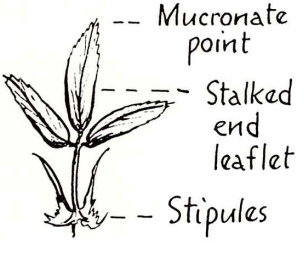
Long before the part played by this organism was understood it was customary for an area to be "blessed" prior to the sowing of the seed. This consisted of dressing the area with soil obtained

LUCERNE – a Medick





A Tripped Floret



A Leaf

from an adjacent lucerne field. So the bacteria were spread, and a good crop resulted.

This method is now replaced by inoculation of seed, prior to sowing, with cultures of the nitrogen-fixing bacteria.

Things to do:

1. Grow a small crop from seed. Halve the seed and inoculate only one half.
2. Make a special study of the bees, or other insects visiting lucerne.
3. Write and illustrate a Lucerne Story from your observations and what you can learn from farmers and the Department of Agriculture.
4. Lucerne is a medick, not a clover. Medicks have the end leaflet on a stalk. Find other medicks, e.g. black medick and burr clover.
5. Look for bacterial nodules on lucerne roots. Put a plant in water on the Nature Table.
6. Compare with other members of the legume family, flowers, pods and leaves, etc. Stage a nature table exhibit of medicks and their relatives (clovers, lotuses, melilots).

THE PLANTS UNIT, 2 THE CROPS

Crops are important in our lives not only for the production of food for human consumption but for industry and conversion into meat and animal products. Crops on the dairy farm are called forage crops. They are plants which store food in their leaves, stems, and roots. Those which store food in their leaves—e.g. rape, derive their food directly from carbon dioxide and sunlight by the process of photosynthesis which manufactures sugars and starches. Some use the stem for storage—e.g., chou moellier, while others have swollen roots—e.g., beet and swedes.

Group D—Food Stored in Paddocks

In some districts of New Zealand it is possible to manage the pastures so that periods of food shortage are rare and can be met by feeding out hay or silage. In other areas, particularly in the South Island, it becomes necessary to supplement pastures in summer droughts and in winter when the pasture growth is dormant. It is in these times that turnips, swedes, chou moellier, maize, and fodder beet are used.

The Cabbage Family

Turnips, swedes, and chou moellier are the members of this family found as stored food in the paddocks of the dairy farm.

Swede and turnip crops generally follow pastures which have run out and require renovation. The early maturing soft white turnips can best withstand the hot dry weather and are the type sown under more arid conditions. Swedes, on the other hand, are largely confined to districts with an ample rainfall. The time to sow is regulated over a large part of the country by the appearance of the grass grub beetle which may be on the wing at any time between October and December according to climatic conditions. Sometimes the beetle is evaded by sowing before it is likely to appear, enabling the plant to reach the rough leaf stage, after which the beetle is not troublesome. More often the crop is sown about December in the hope that the flight will be over before the plants appear.

Chou moellier is a valuable nutritious fodder characterised by rapid and vigorous growth. It is grown mainly for its foliage but the stems are also edible if not allowed to get too woody. Its succulent nutrients make it suitable for cows in milk but to prevent tainting the milk it is fed to the cows just after milking. The crop is usually cut and carted to the stock but it can be eaten where it grows, although this is wasteful.

Enemies

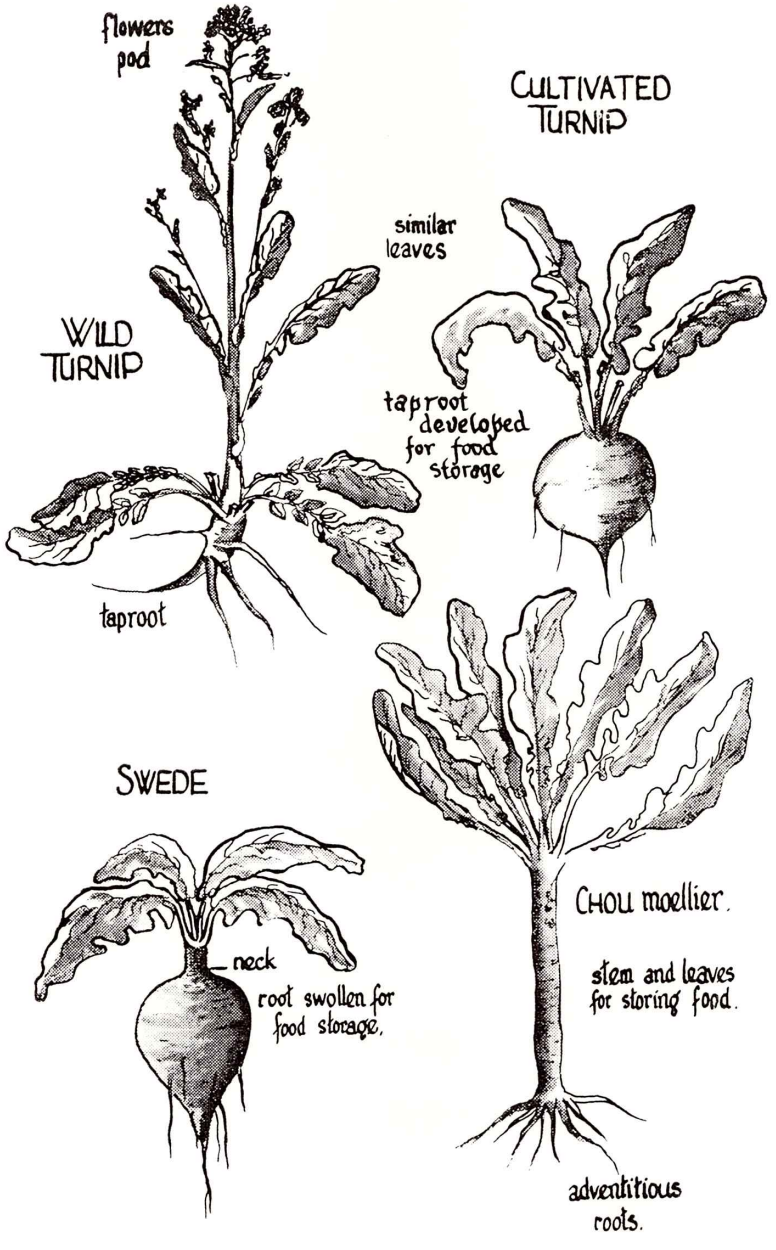
Clubroot and dry rot are both fungus diseases which attack turnips and swedes. Turnip mosaic also attacks these, but it is a virus disease spread by the grey cabbage aphis carrying infected sap from plant to plant. The larvae of the diamond backed moth cause an appreciable amount of damage by devouring the leaves of turnips, swedes and chou moellier. Already mentioned is the grass grub; and, again, there is that most obvious pest, the white butterfly. Both the diamond backed moth and the white butterfly are largely controlled by parasitic wasps which lay their eggs in the larval and pupal stages, the young larvae feeding on the host.

Nature Study of the Cabbage Family

The family includes weeds, vegetables and flowers which grow in our gardens—e.g., shepherd's purse, Brussels sprouts, wallflowers. Those connected with the farmer and the home garden are worth special studies as they are so important to our livelihood. The parent plant is the wild cabbage, a broad-leaved plant growing in seaside areas (look for it if you live by the seaside), and from it plant breeders have produced many of our garden vegetables.

Plant Portrait

All members of the family have a very characteristic flower and fruit which you can observe and compare with others of the family when your school garden crops flower. Grow some of these crops in small areas and make a life history study from seed to seed. This is what you will probably find:—


flowers
pod
WILD
TURNIP
taproot
CULTIVATED
TURNIP
similar
leaves
taproot
developed
for food
storage
SWEDE
neck
root swollen for
food storage.
CHOU moellier.
stem and leaves
for storing food.
adventitious
roots.

The Seeds—contain stored food-oil for the growing plant.

Exp. I: Crush a turnip or rape seed on a piece of paper and hold it to the light.

Exp. II: Grow some cabbage family seeds in a saucer with damp blotting paper. Cover with another saucer until germination.

Exp. III: Sow seeds in school garden areas about November, and observe the life history, somewhat as follows:

The Young Plant

First the smooth seed leaves (cotyledons) appear, followed by the first foliage leaves which are rough and hairy.

I. Draw different leaves as they appear.

II. Compare swede and soft turnip leaves.

The Adult Plant

1st Year: Note whether the plant stores food in its roots, stem, or leaves. In the root-storers the outside skin, which compares with the bark of a tree, can be peeled off (bast or phloem). The main food storage part inside, contains sugar—swedes 7 per cent., turnips 5.5 per cent.

I. Compare turnip and swede with relation to (a) taste, (b) neck, (c) colour.

II. Comparison of rooting systems.

III. Cabbage family insect community and visitors (Nature Table display.)

2nd Year: As these crops you have planted are biennials they will not flower till their second year and will have to be left in the garden for the flower and seed study. The flowers have four clawed petals in the form of a cross (crucifer, the family name—cross bearer). At the base of each claw is a nectary to attract insects for cross pollination. The six stamens are in the form of four inner long and two outer short stalked stamens, and the pistil is in the centre of the flower. The seed boxes split on either side of a middle wall, to which the seeds hang.

I. Compare flowers and seeds of the crops you have grown with their relatives. Look at sepals, petals, stamens, seed boxes.

II. Make a chart to note insect visitors pollinating the flowers.

III. Compare soft turnip and wild turnip.

The Beet Family

This is a seaside family, and one of our native examples is the New Zealand spinach. Fodder beet is the result of crosses between mangolds and suar beet, and is an ideal winter supplement

for both dairy cows and pigs. If grown on good land and well cared for, it is very high yielding, and little troubled by pests and diseases.

Beet seed is in a cluster containing from one to four true seeds embedded in a corky outer husk. A single cluster, therefore, produces several seedlings which develop into a closely intertwined bunch, difficult to separate. To prevent this the seed is sometimes rubbed, that is the outer husks are rubbed off leaving the single seeds which are sown in late October.

Fodder beet can be fed at any time, without the need to ripen, and both the roots and tops can be used. The root has a very high sugar content, about two-thirds of the total dry matter, while the tops are a valuable source of protein and minerals.

Nature Study of the Beet Family

I. Comparison of seeds of cabbage and beet families.
II. Crop families and their relations. (Nature Table).
III. A study of food storage with specific reference to chou moellier, turnip, swede, fodder beet.

Some simple experiments to demonstrate the presence of stored food:—

Exp. I: After the chlorophyll has been removed from a leaf by boiling in clear methylated spirits, application of iodine will give a blue colour showing the presence of starch.

Exp. II: Keep a plant away from the light for a week and repeat above experiment. This shows sunlight is necessary for the plant to make food.

Exp. III: Taste fodder beet and note sweetness.

Exp. IV: Heat a piece of fodder beet slowly in an enclosed vessel. The residue will be a sticky, sugary caramel substance.

Group E—Food Stored in Stacks (Conserves)

As we preserve fruit and jams for use in the winter when many foods are not available, so it is necessary to make hay and silage to store the green grasses, at times when the growth is vigorous, for use as a food appetiser when pastures are scarce.

History of Harvesting

Some of the more recent "cast offs" of the farm implement museum may still be seen in the implement shed or lying about on the farm. An interesting history can be composed by comparing these with the machines the farmer uses today.

Cutting

(a) Handcutting with a sickle.
(b) Handcutting with a scythe—a team of mowers.

(c) A mowing machine drawn by horses.
(d) tractor-drawn mower.
(e) Hydraulic lift mower using power take-off from tractor.

Hay Turned Over and Dried

(a) By hand in the hayfield using wooden rake or pitchfork.
(b) Tractor-drawn tedder, with rotating drum of spikes, turned swaths and flung into windrows.

Gathering In

(a) Raking into windrows.
(b) Tiprake—mechanical rake drawn by horse.
(c) Tedder or side rake.

Into Storage

A. (i) Gathering out of windrows into dray or springcart.
(ii) Cocking or ricking, hay from windrows stacked into cocks or ricks and drawn to stack.
B. (i) Gate sweep drawn by two horses—hay taken straight to stack.
(ii) Sweep operated by tractor.

Stacking

(a) Forked with pitch fork on to a stack.
(b) Mechanical stacker operated by a horse.

Baling

(a) Hay gathered from windrows and taken to baler.
(b) Pick-up baler, hay picked up and baled in field. Bales taken to barn for storage.

The Hayfield

Many grasses are used for hay, the most important being cocksfoot, timothy, canary grass, as well as the pasture plants—lucerne and red clover. In the hayfield, with its tall luxuriant growth, climbing weeds are often found—e.g. tares and cleavers. These can afford a good study for your Plant of the Week on the Nature Table.

Nature Study of the Hayfield

I. Identification of grasses by leaves.
II. Nature table display of grasses in flower.
III. Project on clover-like plants.
IV. Observational trip questions on identification by seed heads.
V. Write and illustrate a history of harvesting.

Silage

Almost any class of fodder crop, with the exception of roots, can be made into silage. The crop is harvested in its green succulent state but it is stored before it has time to dry. The storage

place is either a pit or a silo where the crop is stacked so as to exclude as much air as possible. As a result of storing in this way strong fermentation is set up and the temperature rises rapidly. By increasing the pressure, and so excluding air, the fermentation and temperature can be controlled. The resulting silage is yellowish-green to dark brown in colour.

Fermentation Science

Respiration of the plants continues as long as the air supply lasts, and then as oxidation becomes incomplete the sugar is turned into acetic and lactic acids instead of carbon dioxide and water. The result of these and other chemical changes is a rise in temperature throughout the whole mass, and as these chemical changes gradually cease the temperature will fall.

Exp. I: Take a preserving jar, cram full of grass clippings and seal down. Insulate with carpet underfelt. In four days take off the lid and feel the grass in the centre of the jar, or take temperature.

Exp. II: In the compost heap, at home or school, place a thermometer so that the mercury end is in the middle. As grass is added, take temperature every two days. This should be done in spring.

As all of the above topics are seasonal it is necessary to give a brief seasonal outline. This should merely be a basis for wider planning of the year's work. Where Nature Table displays are mentioned they should be wholly group efforts. In weeks between the displays, however, the teacher may continue the general theme of Crops by use of such methods as the Plant of the Week.

A SEASONAL OUTLINE

Crops

Term 3 (Spring)

Study of seeds, turnip, swede, chou moellier, beet. Prepare garden and plant own crops in small areas. Plant Life history studies.

Term 1 (Summer and Autumn)

Cabbage family insect community. (Nature Table display.) Project, cabbage family plants you have grown with special attention to flowers and seeds.

Term 2 (Winter)

Crop families and relations. (Nature Table display.) Food storage study and test for food qualities. Comparison of rooting systems—tap, adventitious.

Conserves

Term 3 (Spring)

Identification of grasses and clovers—e.g., cocksfoot, timothy, canary grass, red clover. Plant lucerne. Nature Table display of grasses in flower.

Term 1 (Summer and Autumn)

Special display of clover-like plants. Observational trip to observe seed heads. Bees on the farm. Lucerne story.

Term 2 (Winter)

Write and illustrate a history of harvesting for display. Fermentation science.

THE INHABITANTS OF THE DAIRY FARM—

2. THE ANIMALS

THE COWS (Unit 3)

Cattle in their Natural Homes

Those who have studied ancient animal life on earth say that the earliest kind of cattle to be found was the amoch or wild ox. Fossilized remains of the amochs have been found in various parts of Europe. They were taller than our cattle, had long powerful horns and very long tails.

Man Takes a Hand

One of the greatest achievements of early man was to capture and tame wild cattle. The difference this made to his life was tremendous. Up to that time man had been forced to spend nearly all his time roaming the forests hunting for food. Now with a supply of food ready at hand he could settle down in one place and turn his attention to other things—building houses, clearing forest and tilling the land. Perhaps no other animal has been such a good friend to man providing him with milk to drink, meat to eat and leather for boots and shoes. About 6,000 years ago milk had already become an important article of food. In fact, so important was the cow to the people of Central Asia that wealth was measured in numbers of cattle, and the cow was made a sacred animal.

The modern high-producing cow is a result of selective breeding. Men have bred producing "machines" on the hind quarters of dairy cattle. The "improvement" has taken the form, in dairy cows, of a deeper and more capacious body necessary for the production of milk. The more grass a cow can eat, the more milk it is capable of producing.

How the Cow is Suited to her New Way of Life

"Safety in numbers" could be the cow's motto, and is a basic principle in the lives of wild cattle, probably because their chief enemies, the wolves, hunt in packs.

An excellent study could begin with leading the children to understand the peculiar adaptations of cattle for success as wild animals, and to think of some of the present day instincts, which children can readily observe, with original habitats. The characteristics which enable the cow to live successfully as a wild animal have rendered her of great use to us as a domestic animal.

Cattle wandered as regarious animals over the swampy and sometimes forested plains of Northern Europe. They had to contend with marshy ground, forested areas and predators. Devices to overcome mud, ability to hide and defend themselves, and protective instincts can be seen today.

Suggestions for Field Observations

1. Watch the cows as you approach. When one sees you, do the others look also?
2. Do flies disturb cows when they are resting? How does the cow drive them off?
3. Has the herd a leader? (Ask a farmer about this.) Do the rest of the cows have their places in the herd? in the shed? Does each prefer a certain bail?
4. How are the cow's feet better adapted than those of the horse to walk in mud and marshes? Can you point out on the cow's leg those parts which correspond with our elbow, wrist, knee and ankle?
5. Is the cow a good runner? Watch cows walking on mud, grass and concrete. When does the hoof spread the most?
6. Find what breeds are used on the farm you study and where they come from.

N.B.—Further questions will be found in the Nature Study Handbook (Beggs).

Some Meanings Behind these Characteristics

Two main methods of protection are used by cattle—cunning in hiding and protection of the herd as a unit.

Instinctively, when approached, cattle will turn and face an intruder, forming a barricade of sharp horns. It is said that sometimes cattle would form a defensive circle with horns protruding round the outside.

The cow's hoof is cleft and allows air to enter and escape freely when the cow places its hoof in mud. The softer the ground the greater the spread, therefore the cow loves to wade in swamps.

Cows were never developed for running long distances and perspire only through their muzzles and tongues. Good farmers endeavour to give their animals shade in hot weather and never race them along roads.

The Cow as a Machine

How is the cow adapted for converting grass energy to food energy? Besides two sharp horns, the cow has one other important feature for protection—a stomach with four compartments. Two of these act as a storeroom and this means that she can gather enough grass in a short time to last several hours. She can then move to a safe place, regurgitate the grass from the storeroom, chew it and then swallow it into other compartments.

Even today, although not in a hurry, or in danger of attack, the cow still munches the cud. The digested food is transferred into the bloodstream and produces milk.

Class Activity

Watch cows eating when grass is very long, very short, and about 6 inches. Count the number of jaw movements. Watch the ball of grass being brought up to the mouth and count how many times the cow chews it.

You Can Discover that . . .

The best grass length is about 5 inches, which is obtained by rotational grazing of pasture. When the grass is long the cow uses its tongue to grip and pull. She takes very big mouthfuls, but cannot swallow it all and shakes off excess. The cow eating shorter grass keeps her head down and is able to consume more. When the grass is too short there is no grip.

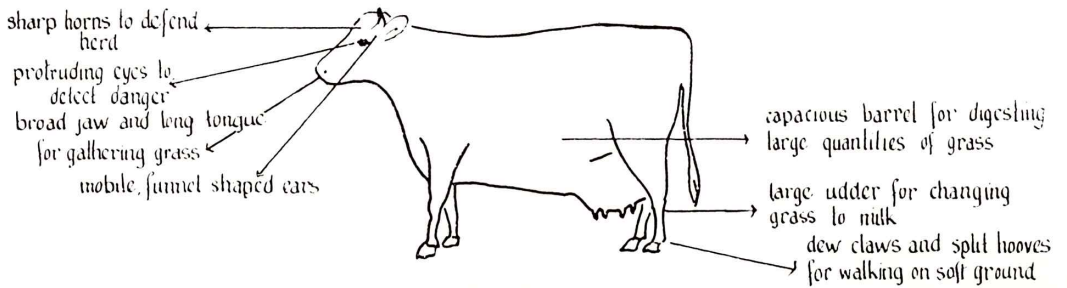
With grass 5-6ins. long the cow eats 150lb. per day.

With grass 8ins. long the cow eats only 70lb. per day.

With grazed pasture it can eat about 45lb. per day.

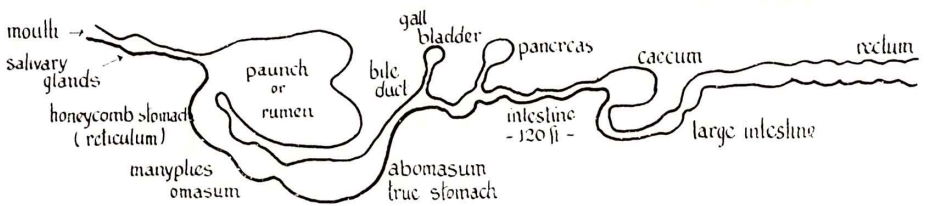
This will demonstrate the importance of rotational grazing as a cow must have 100lb. of grass each day. The optimum length is 4-5 ins.

As cows are grass and herbage eaters their teeth are specially arranged for this. There are eight front teeth on the lower jaw and a horny pad opposite them on the upper jaw. Behind these on each jaw there is a bare place, then 6 grinding teeth on each side. The cow loses the first milk teeth and has her first pair of permanent incisors at about 18 months. She has her complete permanent set in four years. From this time on the teeth begin to wear and at five years they show dark marks. At 8 years they are well worn and show permanent spaces. As the teeth are wearing parts they are useful to the farmer for estimating the age of his animal. To compare the teeth of various farm animals and link them with grazing or feeding habits makes an interesting study. The cow chews from side to side. As the upper jaw is wider than the lower it can only grind on one side at a time. It does about 40,000 jaw movements each day.


sharp horns to defend herd
protruding eyes to detect danger
broad jaw and long tongue for gathering grass
mobile, funnel shaped ears
capacious barrel for digesting large quantities of grass
large udder for changing grass to milk
dew claws and split hooves for walking on soft ground

SPECIAL ADAPTATIONS of the COW

Mouth - huge quantities of fibrous food (cellulose) taken in quickly → Rumen or paunch food stored here for chewing the cud later → Honeycomb stomach - food begins to break down → Manyplies (omasum) water is removed → True stomach (abomasum) juices digest part of the food → Long intestine - for digesting fibre (cellulose) and absorbing food



New Zealand as a Home

Samuel Marsden was the first man to realise the importance of dairy cows in New Zealand. He brought the first cows here in December, 1814. Since then, many fine breeds of cows have been brought to New Zealand.

Refrigeration made it possible for dairy produce to be landed in good condition in the U.K. and Europe. Before 1880 dairying had been confined to supplying dairy produce and milk to the consumers in the towns and dairying was carried on near the centres of population. After 1890 dairying entered the field of those industries producing for export. As the industry developed there was a considerable change in the breeds used, Jerseys largely replacing Shorthorns or Shorthorn cross cows, and by 1912 about 30% of the dairy cows were Jersey or Jersey cross.

Now there are 40,000 dairy farmers in New Zealand milking more than 2 million cows. Two hundred and fifty thousand of these cows are on town milk supply farms.

THE CALVES

PROJECTS FOR CALF CLUB MEMBERS

Getting to Know Your Calf

Find out how her ancestors lived and discuss their original habitat (see Group F). The job of rearing the pet will be more interesting if its habits and adaptations are observed and its needs understood.

The Needs we have to Supply

We are mammals, responsible creatures. We care for and help those weaker than ourselves. A class discussion will bring out the special needs and adaptations of mammals, especially calves. Discuss this in terms of the habitat and protective habits of wild cattle. This will convince the children of the need for adequate shelter and protection and careful feeding. For children with calves this can be followed by home observational projects such as—

Shelter

How can we provide shade?

Discuss the way in which other mammals keep cool (a feature of mammals is constant temperature). From which parts of its body does your calf sweat?

Food

Discuss the special adaptations of ruminants. (See Group F).

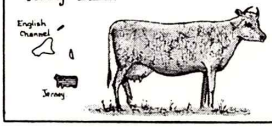
Keep a diary of the way you feed your calf and when the milk teeth appear.

When does it start chewing cud and eating grass?

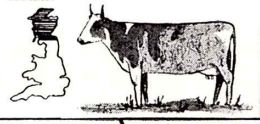
Dairy Breeds and their Homes.

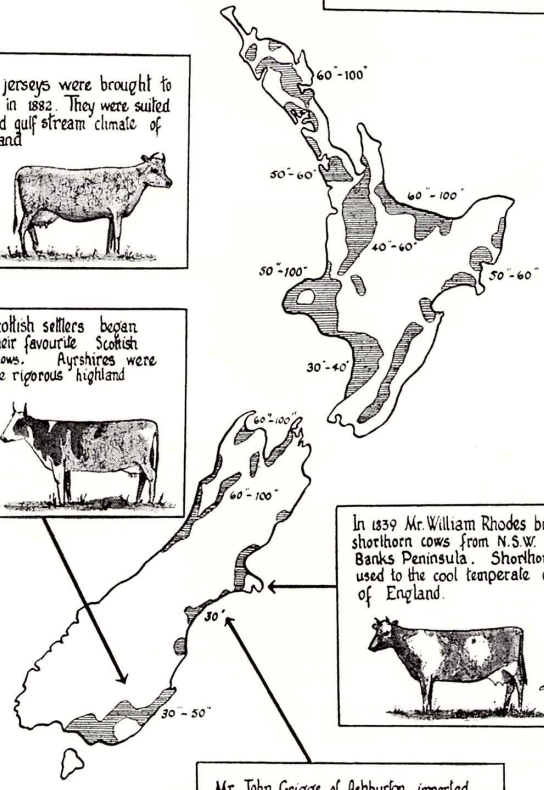
Samuel Marsden brought the first cows to New Zealand in 1814. Now there are 40,000 dairy farmers milking more than 2 million cows.

Pedigree jerseys were brought to Wanganui in 1882. They were suited to the mild gulf stream climate of Jersey Island

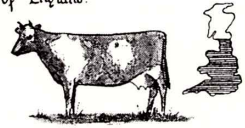


In 1848 Scottish settlers began importing their favourite Scottish Ayrshire cows. Ayrshires were used to the rigorous highland climate.

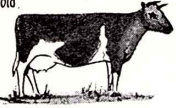




In 1839 Mr. William Rhodes brought shorthorn cows from N.S.W. to Banks Peninsula. Shorthorns were used to the cool temperate climate of England.



Mr. John Griggs of Ashburton imported seven freisan cows in 1884. Their home was the Netherlands, where they faced severe winter cold.



main dairying areas

50"-60" annual average rainfall in inches.

Cleanliness

How do you keep your calf clean and healthy?

These are only a few ways in which the calf club studies can be supplemented.

A Class Trip to a Calf Paddock

Many city school children are not able to keep their own calves, but they will make many valuable discoveries and observations on a trip to a farm. This visit should be preceded by introductory talks and reading. Problems which the children can answer from observation are essential if they are to benefit from such a visit.

Some Suggestions for Observation

1. Does the calf have any side teeth, bottom teeth, top teeth? While at the farm, compare these with the teeth of the dog and the horse.
2. Describe the feel of the calf's tongue and upper pad. What are these used for in the grown up cow?
3. Show in a sketch which parts of her leg correspond to our toenails, foot, ankle and knee.
4. How does she keep flies away?
5. Is her nose moist or dry?
6. Are her ears movable? Why?

Can you creep up to her without being detected?

Home Projects

1. How often does the calf feed and how does it know when meal time has arrived?
2. Does the mother stay near her calf all day, or does she stay away between feeding times?

The Visit as an Aid to Meaningful Expression

Follow-up work is very important, and expression is valuable for bringing loose facts together into a meaningful unit and consolidating material gathered.

A farm vocabulary is a useful way of introducing new terms to the children before the visit. New "farm words" could be added to the weekly spelling list—e.g., ruminant, rotational grazing, regurgitate, gregarious.

Seasonal Activities (Cows and Calves)

April/May. Mow and weigh clippings from 10 yards square of lawn and draw a line graph.

Pupil reports on autumn activities on the dairy farm.

(a) Drying off dairy cows.

(b) Autumn saved pasture.

August/September. Prepare shelter and food for your pet. How does the mother protect, wash and feed her young. Make

plaster casts of footprints. Read "Good rearing of dairy stock" by G. P. McMeekan in the Journal of Agriculture, April, 1954. Read Education Board notes on calf clubs. Prepare shelter with straw bedding, halter, a small box of rock salt and a rug. Select your calf. Leave with mother two days to receive colostrum. Teach the calf to drink from a bucket of whole milk at 90-95°F. twice daily.

October/November. Arrange for calf club day for November. Practise leading it. Complete the graph of weight of grass on 10 square yards of lawn. Superimpose this on the graph of the cow's requirements and deduce from this the farmer's efforts of pasture arrangement, silage, haymaking and cropping. Also mark on this graph a sow's requirements to show that her two litters in May and October fit neatly into the dairy farming plan.

THE PIGS (Unit 4)

It is the pig's ability to quickly and inexpensively put on weight that makes it such a popular animal with the farmer. Pigs will fatten upon a variety of otherwise little used food, such as milk and cereal by-products, or wastes from city restaurants. They may put on as much as one pound of flesh per day and do this with less food than any other animal. This ability to quickly take on fat was a provision in the wild state for building the animal up for the ensuing hard winter months.

Because of its association with the by-products of the extensive grain farm and the intensive dairy farm we find that pig farming in the United States of America is almost confined to the Corn Belt areas, while the intensive dairy farming countries of Denmark, Eire and Holland are well known for their pig-dairy farms. Whereas in the earlier part of this century the New Zealand dairy farmers found themselves landed with such by-products as skim milk (which the pigs conveniently coped with) the dairy farmer of the 1960's finds that he has alternative ways of coping with the by-products. For instance, modern processing factories are able to convert skim milk, whey and buttermilk into concentrated milk sugars or synthetic material.

Therefore, profitable pig farming is now a matter for the expert more than the amateur and the greatest profit will be made only by those who fully co-operate with recent scientific trends. By following the guidance of the experts, carefully planning the pig's diet programme, and seeing that the animals are warmly and comfortably housed, a farmer will still make a substantial profit from his piggery.

Again, pigs will be managed best if we can appreciate the type of feeding for which they are adapted. The pig is an omnivore

with a small stomach like our own, not suited to such bulky foods as the cow's stomach.

Whole milk is a good food for most farm animals. It is a balanced food containing carbohydrate (sugar), hydrocarbons (fat) and proteins (casein and albumen). This, however, is too expensive to feed to pigs, indeed the usefulness of the pig lies in the fact that it makes use of the waste portions of the milk, e.g., skim milk and whey. These waste products require supplementing with concentrates of less bulk, e.g., cereal by-products. Whey consists mainly of sugar and water and because of its bulky nature it requires supplementing with proteins such as meat meal.

PROJECT METHODS

The summer visit to the pig farm should be preceded by an outline and explanation of the projects which will be undertaken throughout the year. Activities could run along the following lines:

Keep a group booklet entitled "Events in the Pig's Year". As well as making notes on the feeding, breeding and marketing of pigs, this should be supplemented with illustrations of the various breeds of pigs.

Make a large display map of the piggeries. Arrows and labels can indicate what is being carried on in each sty or paddock. Notes should accompany the map, with suitable questions provided, e.g., *The Weaners' Paddock or pen.*

What does the weaner eat and drink? Where does it sleep? Does it still live with its mother? How old is it when it ceases to be called a weaner?

Observational Questions:

If the pig could have its natural food what would it be and where would it be found?
What do pigs find in the forest to eat?
Why do pigs root?
How does the pig's nose differ from that of other animals?
What is the advantage of pasture feeding to pigs?
What milk products are fed to pigs? What do they contain?
What must be added to them to make complete foods?

PIG HOMES, OLD AND NEW

The wild hog of Europe prefers damp or boggy ground where it can indulge in its wallowing and rooting; although for its nest or home it chooses drier ground such as a thicket, bracken or undergrowth. There, in some hidden spot, it is able to make its warm nest from straw or bracken. Some of the wild hogs of India make for themselves grass "huts" which, complete with a covering "roof" and side "doors", prove how the pig, if allowed to care for itself, well understands the art of nest building.

Homes of the Present Day

With the recent progressive trends in farming there has been a great improvement in the design and construction of pig sties. Once any old out-of-the-way farm shed sufficed for the pig sty; the only thing being considered necessary was that the pig should be held within the sty and not allowed to run about the farmyard. Farmers of this decade understand more about pigs and take this knowledge into consideration when they build their sties. For instance, we now know that the pig is, of all farm animals, the one that is most prone to chills and colds. Therefore, a draughty, poorly built sty would only encourage poor health. H. W. Potts, in his "Pigs and Their Management", lists the following points essential in all sties:—

1. Solid construction, preferably brick or concrete.
2. A solid floor with a fall towards the trough, thus permitting good drainage. Concrete or wooden floors remain dry and warm whereas a soil floor will in time become a smelling mess.
3. The sty should be so built that sunlight is admitted into the building itself, this helping drying out.
4. A high roof providing good ventilation and permitting thorough cleansing of the sty.
5. Large exercise yards, e.g., 1 chain x $\frac{1}{2}$ chain.

The pig is naturally a clean animal having clean habits and a certain amount of Pride of House, for pigs are known to keep their beds clean even in the most ill-kept sties. It is easy to see the connection between the wild hog and the domesticated pig when one compares the beds or nests of these animals; both like to hide under a covering of straw, probably to escape annoying flies, or perhaps to escape strong sunlight.

In addition to the usual pig sty there is also the Farrowing House. This is a small house where the sow gives birth to her litter. A rail around the walls prevents overlaying, i.e., the sow turning and lying upon her piglets—an important factor in mortality. Provision is made for feeding the piglets on an extra ration of meat-meal by the "creep"—a low rail below which they can run to reach the feeding trough.

Observational Questions:

The original wild pigs made their homes in the thickets and undergrowth. They made their beds in the dry ferns and amongst other warm, dry plants.

In what way does the farmer try to reconstruct the original habitat of the pig when he builds his pig sties?

What special type of sty is built for farrowing and protecting the piglets?

Where does the farmer feed (a) his pigs?
(b) his piglets?

Litters of pigs vary in number. Count the number of teats on the sow, then count the number of piglings in her litter. Does the sow produce milk for each teat or does she just provide milking teats for the number of her litter? Most litters have a "runt" which is undernourished. Can you find the runt in the litter you are studying?

PIG HABITS, THEN AND NOW

Most people are familiar with the wallowing and rooting of pigs. Such habits are age old and most likely were practised by the earliest pigs. Since the pig has little hair covering its body it is frequently attacked by flies and other insects. In order to rid itself of these pests the pig has learned to wallow in the mud. The pig also has a tough, thick skin which prevents free perspiration through the pores. Wallowing in the mud is therefore a means of keeping the body cool. Possibly taking a mud bath also has the effect of ridding the body of vermin.

"Rooting" is also a pig word and this term probably originated with the pig's habit of digging for roots. Due to its very sensitive nose and its strong canine teeth (called tusks) it seems only natural that the pig should make full use of these rooting implements when searching for food. Rooting sites of the wild pig are often seen in or near areas of bracken fern while the rooting of the domesticated pig is generally restricted to its exercise pen. Farmers sometimes are forced to place a ring or short wire in the noses of their pigs. This prevents the animals from rooting up all of their exercise pens.

The fences surrounding the pig yard are generally lower than the ordinary farm fence. Wire netting is occasionally fitted, being dug into the ground to prevent the inhabitants from burrowing under their fences. Barbed wire run along the ground serves the same purpose.

Observational Questions:

How is the pig covered? Do you think the hair is thick enough to keep off the flies?

Why does the pig wallow in the mud—is it because the animal is dirty by nature or because it is trying to keep clean?

Is the pig's head straight in front or is it dished?

Is this dished appearance ever found in wild hogs?

Notice that the Tamworth has a long straight nose. What does this tell you about the early history of that particular breed?

Why do the farmers place rings or wires in the pig's nose? Can you see any connection between this and the way in which the wild pig hunts for food?

What special precautions do you find in gates and fences to prevent pigs escaping? In what way do the fences differ from the other farm fences?

PIG FAMILIES

The gestation period of the sow is from 112-116 days. Thereupon she may give birth to a litter comprising up to fourteen piglets. These piglets, which in modern farms are born in a special farrowing house, feed from their mother until they reach the weaner stage, generally from six to twelve weeks after birth.

On the dairy-pig farm the weaners are then fed on skimmed or whole milk supplemented by bran or some inexpensive cereal such as maize or oats; with whey, meatmeal is used. Such food forms the basis of the pig's diet throughout its entire life.

The following are the most common terms used in connection with pig husbandry:

Piglet: unweaned baby pig.
Sucker: unweaned piglet generally of three weeks or more.
Weaner: weaned piglet, ideally about 8-10 weeks old and 40-50lb live weight.
Slips: Twelve weeks, suitable for fattening.
Porker: $4\frac{1}{2}$-$5\frac{1}{2}$ months old and 60-100lb in weight.
Baconer: $5\frac{1}{2}$-7 months and 160-210lb in weight.
Chopper: any age beyond 7 months.
Stores: 4-6 months, suitable for fattening.
Boar: adult male.
Sow: adult female.
Barrow: castrated male.
Gilt: young female up to the time she farrows her first litter.
Farrowing: giving birth to piglets.

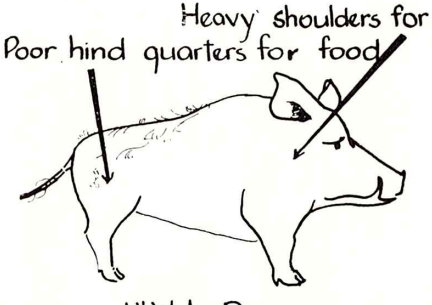
WILD PIGS AND FARM PIGS

1. History of the Pig

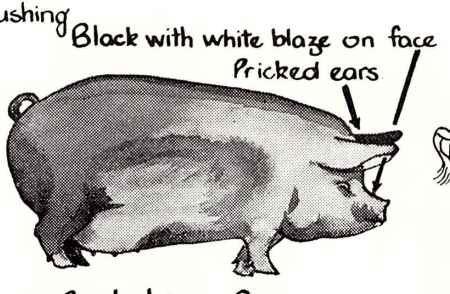
Many species and varieties of swine are found in different parts of the world and most of them exhibit strong traces of general family resemblance. The pigs, although not numerous in species, are the most widely distributed of the ungulates, due probably to their omnivorous habits, intelligence and remarkable courage.

The domestic pig as we know it is the tame descendant of the spirited true pigs of the Old World. Fossil remains of these ancient "wild" pigs have been found in Europe and India and a Chinese scholar has estimated that domesticated swine were common in China as long ago as 2900 B.C. The Mosaic Law forbade the Hebrews to partake of the flesh of swine, proving that swine were common in the earlier days of the Old Testament. From English history we learn that in the days of the Plantagenets wild swine fed and sheltered in the woodlands close to London. James I hunted them in Windsor in 1617 and even down to the year 1683 these animals still had their haunts in the more secluded parts of England. The wild boar may still be found in most European countries, where it is shot during forest drives or simply hunted for sport.

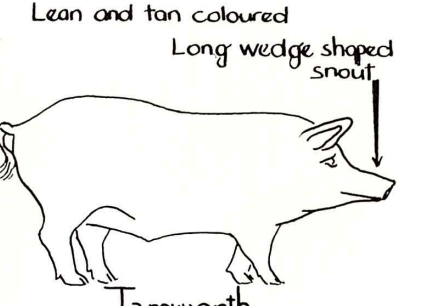
SOME COMMON BREEDS OF PIGS



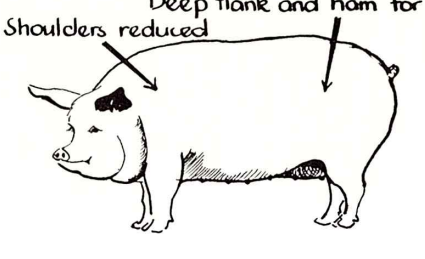
Wild Pig



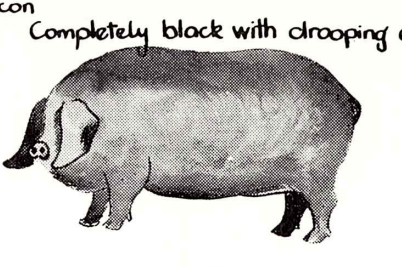
Berkshire Sow.



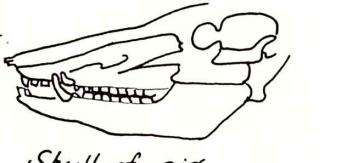
Tamworth.



Large White



Large Black.



Skull of pig.

Dentition $\frac{3\ 1\ 4\ 3}{3\ 1\ 4\ 3}$.

Introduction to the New World

Pigs are native neither to Australia nor New Zealand, so these animals were not introduced into Australasia until the late eighteenth century.

However, it is quite likely that the Maoris took aboard their fleet canoes pigs and fowls as well as dogs; but only the dog survived the long voyage to New Zealand. Had the pigs been landed safely they would no doubt have flourished on the bracken fern as did the pigs which were later introduced by Captain Cook and Governor King.

Cook's Tahitian interpreter, Tuapaea, was told by the North Cape Maoris that "to the N.N.W. was a large country to which some people had sailed on a very large canoe which passage up took them a month". From this expedition "a part only returned, who told their countrymen that they had seen a country where people ate hogs, for which animal they used the name Booah (pua'a) as it is used in the islands".

Although Tuapaea ridiculed this story the similarity of the word pua'a to its Polynesian equivalent is most convincing.

Pigs of unspecified breed were brought to Australia with the First Fleet and the first Australian census of livestock (May, 1788) revealed that pigs outnumbered both cattle and sheep. During the early colonization of Australia sows were distributed amongst the early convict farmers. It is probably the final progeny of these early domesticated sows which form the variety known as the "Wild Pig". For, after all, these particular pigs which run wild in our native bush are domesticated pigs which have "gone bush".

SCIENCE AT THE MILKING SHED (Unit 5)

Farming today is a science. The farmer has enlisted all sorts of modern scientific aids to assist him in his work. Every country boy knows the milking shed. Here is an opportunity for school science. Have a discussion with the class on how science helps. List such topics as the following, with their farm application:—

The Job	Old and New Method		The Scientific Principle
Milking	By hand (or foot-powered machine)	Power-driven machines	Air pressure
Separating cream	Pans	Separator	"Centrifugal" or inertial force
Making butter	Hand churn	Factory	Coagulation of fat
Making cheese	Curds and whey	Factory	Coagulation of casein (rennet)
Control of disease	Herbs, superstition	Scientific control	Hygiene, anti-biotics,vaccination

Background to Farm Science

(1) How does a milking machine work? Air Pressure

The milking machine is basically a suction pump working by air pressure, firstly to get the milk from the cow, and secondly to get the milk to a collecting point.

There are a number of parts to the machine and these will be taken one at a time.

(a) The Cups

These are metal cylinders inside which fit rubber inflations.

The aim of the teat-cup is to imitate the sucking action of a calf. To do this the machines draw the milk from the teat, and along the milk-pipe to a releaser.

The inner portion of the teat cup leads to the milk pipe. The area between cup and inflation is connected to the air pipe. The milk pipe is connected with a drum called a releaser (described further in the article). The releaser and milk pipe are under a constant vacuum to draw milk from the teat and deliver it to the vat. The air pipe, however, is connected alternately to the vacuum line and to the air by means of a pulsator valve. When the vacuum is applied to this air pipe the pressure is the same in the inner portion around the teat and also in the area between cup and inflation; the inflation is straight and not pressing on the teat (see diagram); and milk is drawn from the teat. When the pulsator releases the vacuum in this area the air pressure surrounding the inflation pushes the inflation against the teat, constricting and massaging it in much the same way as a calf does in sucking; the milk reservoirs above the teat have time to fill with milk, and this is drawn off with the next vacuum.

(b) The Pulsator

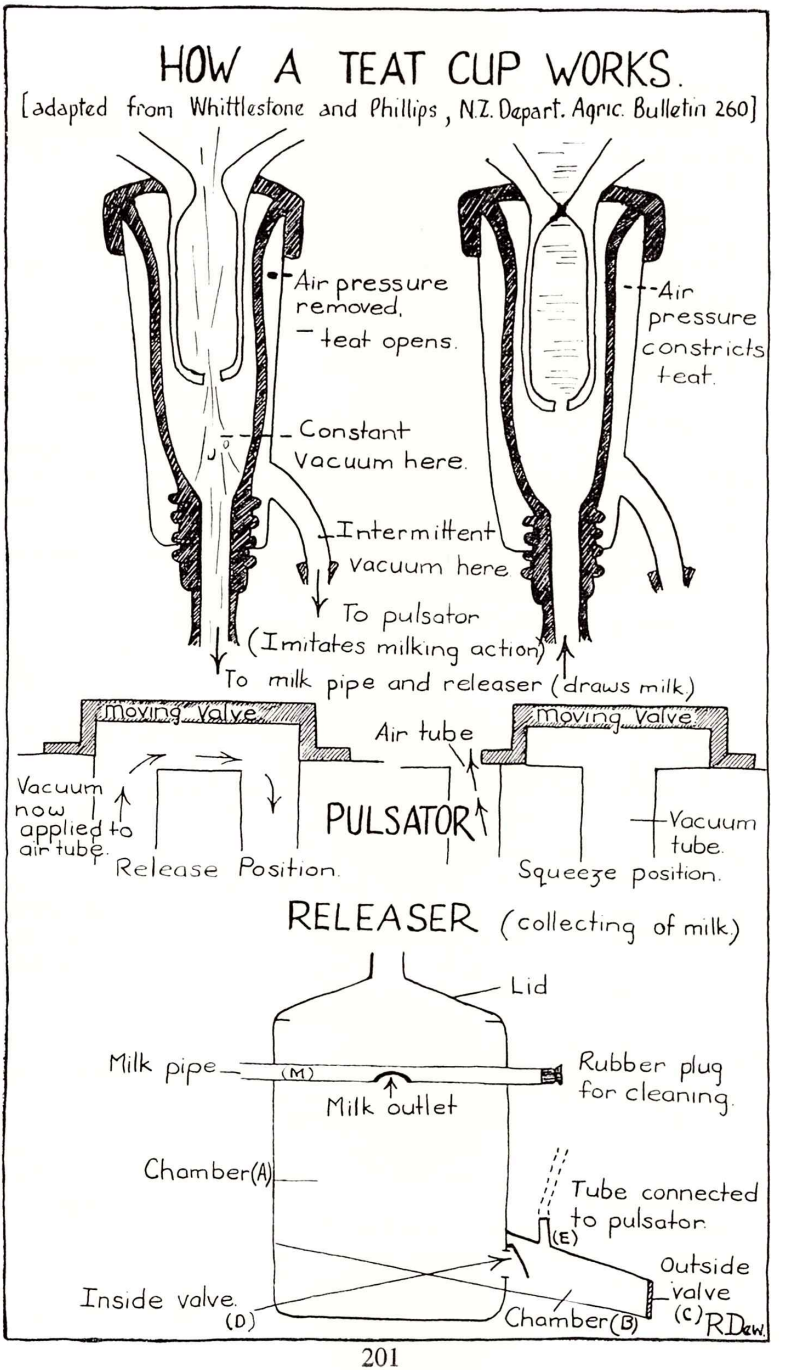
In the first of the two accompanying diagrams, the moving valve connects the vacuum pump with the outer portion of the cups. The cups are now drawing milk.

In the second diagram, the cups are connected with the outside air and no milk is drawn.

(c) The Releaser

If air is taken away from the machines there is a vacuum inside. To enable the milk to escape without reducing the vacuum a releaser is used.

The releaser consists of two chambers. The main one A into which flows the milk from M, and B the "split" chamber which opens to the air through the flat-valve C. At E is a tube connecting the split chamber to a pulsator valve which alternately connects the chamber to the vacuum and then to the air. When B had no air in it, milk flows in freely through the valve D. C is pushed closed by the air pressure of the atmosphere. When B


HOW A TEAT CUP WORKS.
[adapted from Whittlestone and Phillips, N.Z. Depart. Agric. Bulletin 260]
Air pressure removed, teat opens.
Air pressure constricts teat.
Constant vacuum here.
Intermittent vacuum here
To pulsator (Imitates milking action)
To milk pipe and releaser (draws milk)
Moving Valve
Air tube
Moving Valve
Vacuum now applied to air tube.
PULSATOR
Vacuum tube.
Release Position.
Squeeze position.
RELEASER (collecting of milk)
Lid
Milk pipe
(M)
Milk outlet
Rubber plug for cleaning.
Chamber(A)
Tube connected to pulsator
(E)
Outside valve
Inside valve.
(D)
Chamber(B)
(C)
RDew.

is opened to the air D closes and milk flows into the collecting point called the vat through the flap-valve C. To make the explanation clearer a diagram showing the whole machine is given.

Experiments with air pressure to demonstrate principles of milking machines.

Experiment 1—To Find Out how Teat Cups Work

Suck air out of a glass bottle—close the bottle with your tongue. What happens?

Why does the bottle stick to your tongue? Is the bottle being pushed or pulled on to the tongue?

Do the inflations get pushed or pulled on to the cow's teat?

Experiment 2—Finding Out how Milk is Brought to the Releaser

Suck up some liquid with a straw. Why does the liquid rise in the straw? Did you realize you were removing air from the straw? Use a garden syringe to suck some water from a bucket. Examine the plunger. Try and work out a pump that would pump water from a creek to a tank. Compare it with the vacuum pump.

For further experiments on air pressure see Bulletin supplement No. 2.

Experiment 3—Finding Out how a Releaser Works

Upturn an almost full bottle of water in a soup plate of water.

Why does not the water level drop?

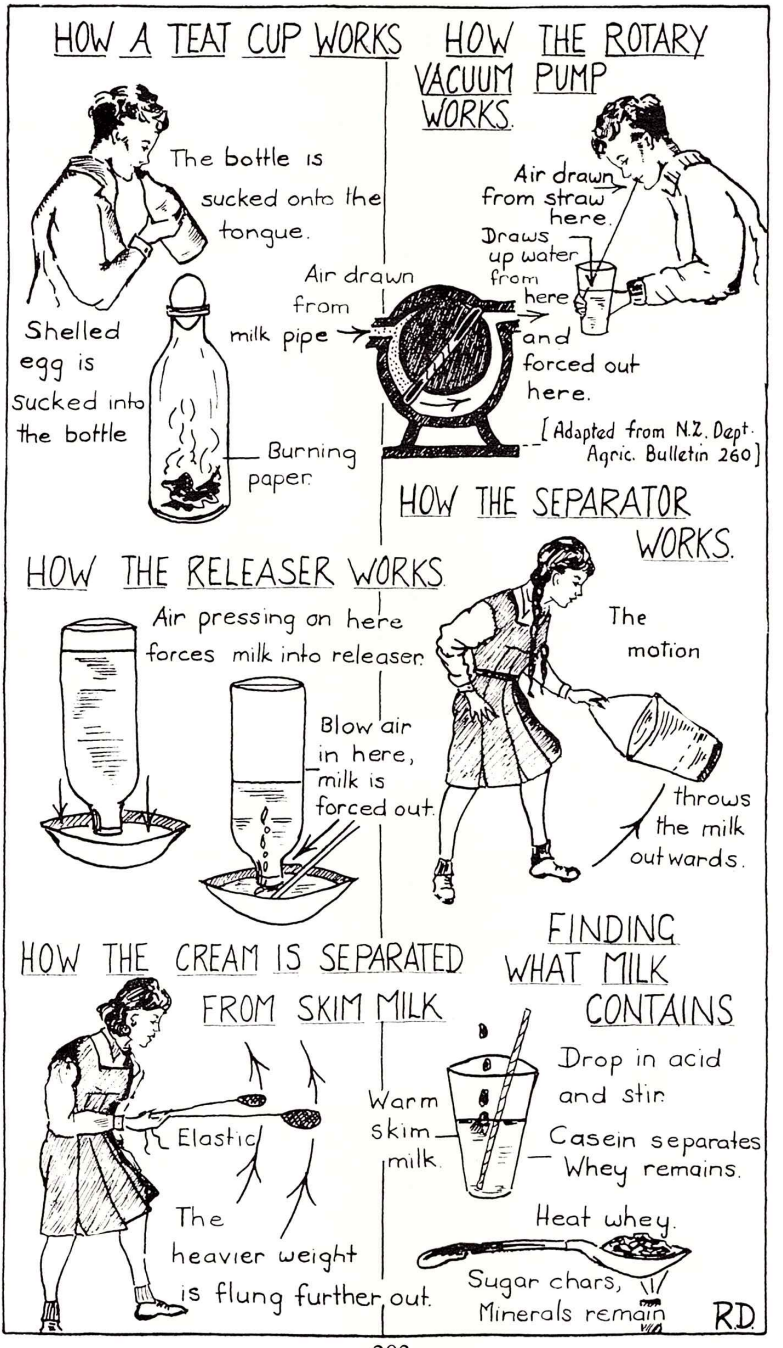
(If this is being done as a class demonstration, colour the water with a drop of ink.)

Note the way the milk is released in the releaser when air is allowed to enter.

How Does a Separator Work? Forces due to Motion

About 3.9% of milk is fat. Most of this fat we call cream. Formerly, the farmer used to put his milk into flat dishes called pans and leave it there during the night. In the morning, the cream, being lighter than milk, would float to the surface. The cream was lifted off with spoons. This was called skimming the milk. The residue left in the pans was called skimmed milk. Today the farmer has a more efficient way of separating the milk using the scientific principle of "centrifugal force" or inertia. The machine that does this job is called a separator.

The milk is separated into very thin layers and very quickly spun in the separator bowl. The cream being lightest is not thrown so far as the heavier solids and water in milk. Therefore the cream can be extracted from the centre of the separator and so sent to the butter factory. The skim milk is taken outwards by what is sometimes called "centrifugal force". It is really only the momentum of the heavier milk particles, taking these outwards, so that the lighter cream globules are forced inwards.


HOW A TEAT CUP WORKS
The bottle is sucked onto the tongue.
Shelled egg is sucked into the bottle
Burning paper
HOW THE ROTARY VACUUM PUMP WORKS.
Air drawn from straw here.
Draws up water from here
Air drawn from milk pipe
and forced out here.
[Adapted from N.Z. Dept. Agric. Bulletin 260]
HOW THE RELEASER WORKS
Air pressing on here forces milk into releaser.
Blow air in here, milk is forced out.
HOW THE SEPARATOR WORKS.
The motion
throws the milk outwards.
HOW THE CREAM IS SEPARATED FROM SKIM MILK
Elastic
The heavier weight is flung further out.
FINDING WHAT MILK CONTAINS
Warm skim milk.
Drop in acid and stir
Casein separates
Whey remains.
Heat whey.
Sugar chars,
Minerals remain
R.D.

Some Separation Experiments

Experiment 1—To Find What Momentum can do

Put some water in a bucket. Swing the bucket by holding the handle and swinging the arm over and over. Do the same with a wet cloth. What happens to the water in the cloth?

Experiment 2

Tie a heavy and lighter weight on to two separate lengths of elastic. The pieces of elastic must be the same length and strength. One weight goes on each piece of elastic. Hold the elastic at the free end in your hand and twirl it round your head. Which weight goes out further? Can you see why cream is not pushed out as far as the skim milk?

Making Butter

When the cream arrives at the factory it has to be made into butter. The cream is a mixture of water and fat, called an emulsion. The factory processing must coagulate the fat globules and so get rid of the water and some other solids.

To do this the cream is put into huge churns. The churns are like big barrels with beaters inside. They are set revolving and this stirs up the cream. Gradually the cream becomes thicker and thicker, as the fat globules flow together and the water drains off. Eventually small chunks of butter form, floating amongst the more liquid water and solids-not-fat called buttermilk. After a short while chunks of butter merge together until a huge mass of butter weighing about a ton is taken from the churn on a big table. Before the butter is taken out the buttermilk is pumped away.

The butter is not wrapped up as yet, but tests are taken, e.g., for saltiness. Salt is added during the churning. The factory manager has to be sure it is not too salty, and not too watery.

For further information write Dairy Production Board, Wellington.

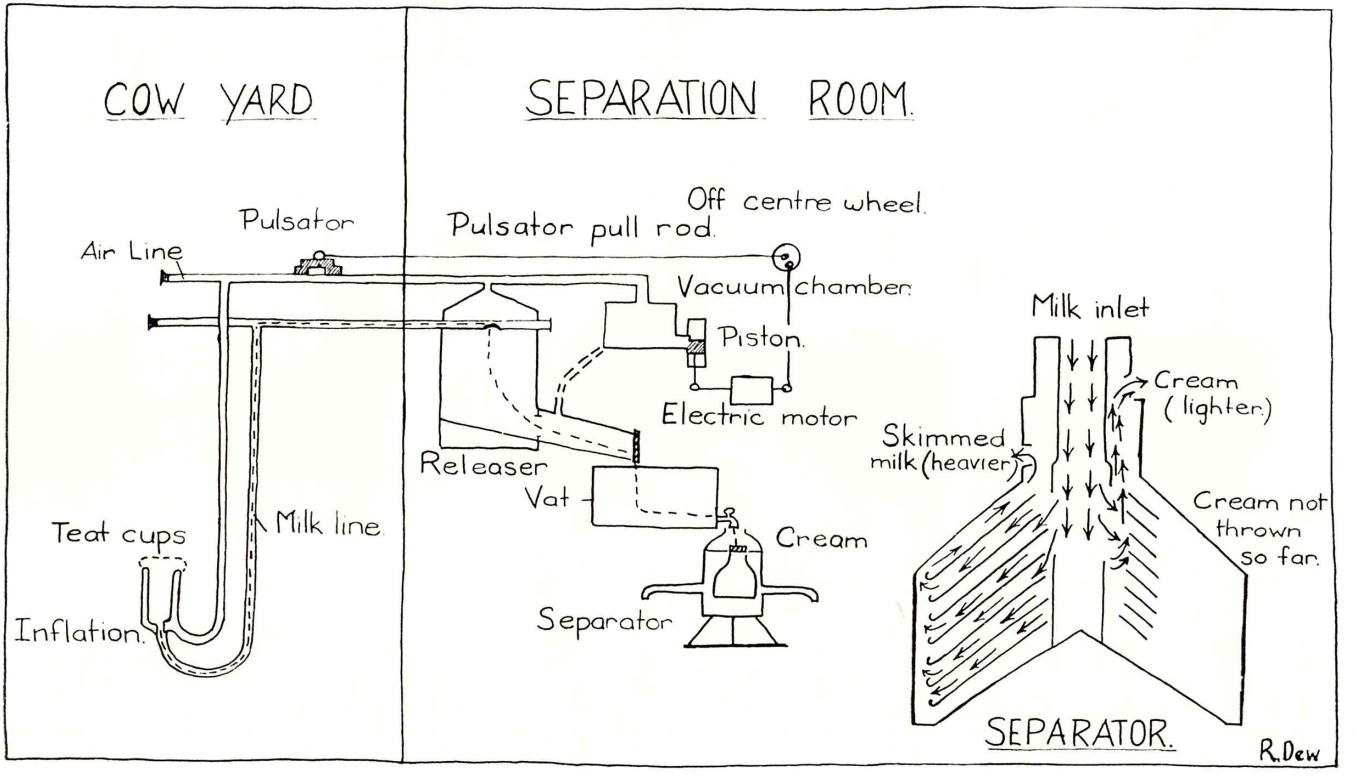
Experiment to Make an Emulsion

Experiment 1

Put some oil or kerosene in water. Shake up the mixture. Does the oil spread right through the mixture? Are there bubbles of oil throughout the water? How long does the suspension take to separate out? Can you explain its colour? Why does milk look white (globules reflect light).

Experiment 2

Using $\frac{1}{4}$ pint of cream beat the cream until butter forms, or shake it in a jar. The temperature should be kept cool.


COW YARD
SEPARATION ROOM.
Pulsator
Air Line
Off centre wheel.
Pulsator pull rod.
Vacuum chamber.
Piston.
Electric motor
Releaser
Vat
Cream
Separator
Teat cups
Milk line
Inflation.
Milk inlet
Cream
(lighter)
Skimmed
milk (heavier)
Cream not
thrown
so far.
SEPARATOR.
R.Dew

Cheese Making

The manufacture of cheese is a means of preserving the two most important constituents of milk, namely fat and casein, and at the same time of providing a palatable, easily-digestible, long-keeping, nourishing food. Rennet, an extract from calves' stomachs, is used to coagulate the casein. When the casein coagulates it carries the fat with it.

To obtain the rennet the fourth stomach of the calf is removed, cleaned, inflated and dried in air. It is cut into $\frac{1}{4}$ inch square pieces and put into water. After 5 or 6 days salt is added and the whole lot filtered to get rid of solids.

Before the rennet is added to the milk a "starter" is used to make a curd. The starter may be a weak acid.

The milk curdles and the curd is cut with a knife. The liquid which is left, called the "whey", is drained off to be used as possible feed for pigs. It contains much sugar.

The curd is cut into big squares, piled on each side of the vat, for draining, then pressed into cheeses and packed for curing.

Experiment to Separate Curds from Whey

Add a weak acid slowly (lemon juice will do) to a small quantity of warm skimmed milk. Stir until the milk curdles then pour off the "whey". Dry the whey on a spoon and taste for sugar. This gives a hard curd of casein which will glisten and crack when dried. A soft curd may be made from whole milk and rennet.

Disease Control in Milk

Because milk is such a rich food, germs live and multiply happily in it.

Some of the germs originate within the cow. The disease which has caused much concern in the last few years is Bovine Tuberculosis. Tuberculosis, commonly called T.B., is caused by bacteria. The bacteria are brought into the milk from the blood. The milk on being drunk can give humans tuberculosis. To combat this cows are tested by injection of other bacteria (Tuberculin test). If there is a swelling where the injection was given, the cow has some trace of the disease. The cow is immediately got rid of, for it can cause the rest of the herd to be infected. Every herd supplying a town milk run must have been tested for tuberculosis. All herds found free of the disease are published in the Journal of Agriculture.

Some diseases occur in the udder. The one most common and causing a lot of concern is mastitis. The milk from one teat may be affected, any of the others giving good milk. When this condition is apparent the cow is said to have a bad quarter. The milk has pus in it and congeals to form a semi-solid. To combat this bacterial disease penicillin and other similar drugs

are used. The use of penicillin has lately caused some concern. Farmers using too much penicillin have found that it has contaminated the milk to the extent that humans drinking it are becoming immune to the effects of the antibiotic when it is used to combat human ailments.

Other bacteria in milk which originate within the cow and cause human sickness are: Undulant fever, septic sore throat, scarlet fever, and diphtheria. Normal milk bacteria cause milk to sour quickly. Disease-causing bacteria are killed by pasteurisation. Pasteurisation is a process, first discovered by Pasteur, a French chemist, whereby germs are killed by heat. The milk is quickly heated to 140 deg. F., then quickly cooled.

Disease can be introduced into the milk from man's uncleanliness. Such sicknesses are: typhoid, paratyphoid, and scarlet fever. These are all killed during pasteurisation; but hygiene on the farm is the most important factor in keeping milk clean. When milk arrives at the milk treating station samples of only a drop are placed on a food which makes bacteria multiply rapidly (plate cultures). The food is kept at a warm temperature and in a certain length of time the amount of bacterial growth is noted. If the milk contains a very small number of human bacteria it is graded "finest", if a small number "1st grade", and if a great number "2nd grade". If the bacterial count is too high, the farmer is warned that his milk may not be used. The farmers are paid by the quality of the milk and its cleanness. Another method of bacterial testing (the reductase test) makes use of the fact that bacteria can decolourise a blue dye, methylene blue.

Because milk contains bacteria which sours it, and the bacteria like warmth to grow, milk should always be kept in a cool place out of the sun. Make sure with school milk that in yard and classroom the bottles of milk are in the coolest place.

Experiments with Bacteria

Keep some milk in a warm place and another sample of the same milk in a cool place and compare the times for souring. Compare two samples to one of which a little soil has been added.

Milk as a Food

The composition of milk varies from cow to cow and herd to herd, depending on such factors as breeding, feeding and season of the year.

Generally the milk required by New Zealnad's biggest cities takes 5000-6500 cows to produce. The average quality of the all over milk supply varies little from day to day. Complete analysis of a representative sample of bottled milk would reveal the presence of over 70 different substances, some of which are present only in minute amounts.

H. H. Somer in his book "Market Milk and Related Products" outlines the constituents and their % quantities as:—

Water	86.9%
Milk Fat	5.9%
Protein (mainly casein but some albumen)	3.2%
Carbohydrates (mainly lactose)	3.1%
Salts	.9%

We will look at these constitutents in turn.

1. Milk Fat

Milk Fat (or butter fat) is probably better for us than any other form of fat. The fat holds large quantities of vitamins, including vitamin A which promotes growth and helps maintain our eyesight in good condition. Fat gives heat, and butter therefore is a good winter food.

2. Protein

Proteins are body builders; they are essential to replace tissues used in our normal body processes and exercise. Milk contains much protein and is therefore a suitable food for growing animals and children.

3. Carbohydrates

Lactose is sometimes called milk sugar. Carbohydrates are useful to give us energy and help the body absorb calcium for bone production. Lactose also helps to keep our digestive tract in good order.

4. Salts

When you sprinkle salt on your vegetables you are using one of very many natural salts. In milk there are many salts which our body needs to keep working efficiently. Our body needs copper and other elements which you may not have heard of. Some of these elements are: magnesium, sodium, potassium and zinc. Milk supplies all of these in good quantity. Milk also contains phosphorous which is important in teeth.

Milk therefore is important to us because:—

(1) It supplies protein.
(2) It supplies fat for heat and energy.
(3) It supplies carbohydrates (sugars) for energy.
(4) It supplies essential minerals and vitamins (calcium, phosphorous).
(5) It is easily digestible.
(6) It has a pleasant taste.
(7) It helps the digestion.

School Milk

Here is a good opportunity to discuss school milk as a food and to encourage children to take a practical interest in its production as an example of modern farm science. Separate the constituents of milk (see Bulletin Supplement No. 2 Earth Science)

and show the importance of each, in its contribution to the food value both of whole milk and of the various by-products of the dairy industry.

ACTIVITIES AND QUESTIONS ON THE FARM

Try to organise a visit to the farm about ten o'clock in the morning. The farmer will then have finished his breakfast and be about to wash up his milking machines. Unfortunately milking time is out of school hours so unless the class stays until about half-past three the actual milking may be missed. However, during the washing up process the movement of water through the machines can be watched. The water is taking the place of the milk.

Hygiene

What chemical does the farmer use to clean the machines? Why does he not use soap? When does he use brushes? What metal are the machines made of? Does the farmer put the milking machines on the cow immediately it enters the bail? Note any precautions against dirt accumulating in the machines.

Air Process

The children can put their thumbs in the inflation and feel the sucking of the machines. They could work out where the air gets into the machines (at the pulsator), and find out where the vacuum line leads. How is a vacuum caused in the machines?

Separating Room

When this room is being examined there will probably be only room for one group at a time. Note the position of the various parts of the milking equipment. Ask the farmer when the separator is started during milking. How quickly does the milk go through the separator? Does the separator help in the milk cleaning process?

The class will be able to watch the separator being taken to pieces for washing. What are the disks used for? Try to trace the passage of milk, skim milk and cream. What happens to the cream immediately it leaves the separator? If the farm is a town supply one there will be no separator but a big vat will be used to store the milk until the tanker from the milk company arrives.

Back at School

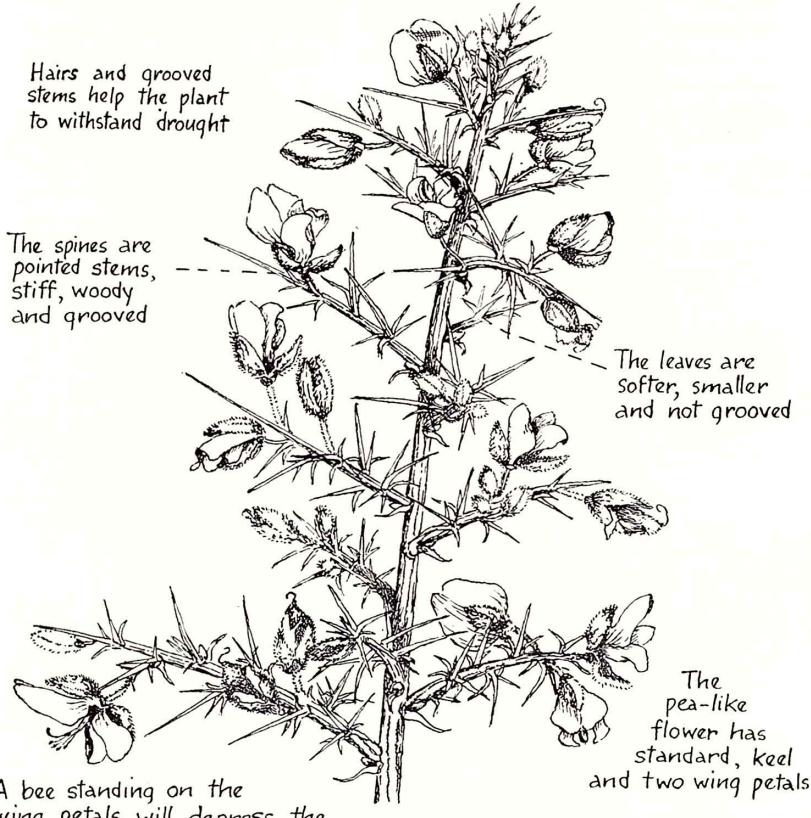
A display of farm machinery could be set up from pictures or things the farmer may have thrown out. A small dairy shed could be modelled with red cord or wool tracing the outline of the milk line.

A drive in milk hygiene, general cleanliness and drinking of milk could be undertaken. Various groups could be given a specific part of the milking shed and cover the area in detail. Suitable topics could be: hygiene; air pressure at work; how a separator works; milk products and their use; disease control; transport; herd records.

The Gorse Patch

A. A. Morgan

Gorse is now a rather common weed on our farms and a scrub plant in many areas of second growth. In both autumn and spring many hillslopes are conspicuous for the blaze of colour from this tenacious and beautiful flowering shrub. It should, then, enter into our Nature Study in the schools—not only as a plant, but as a


Hairs and grooved stems help the plant to withstand drought
The spines are pointed stems, stiff, woody and grooved
The leaves are softer, smaller and not grooved
The pea-like flower has standard, keel and two wing petals
A bee standing on the wing petals will depress the keel; stamens (and pistil) fly up in a shower of pollen dust

Gorse weevils lay their eggs in the pods in spring. In winter they feed on the flowers

home for the community of living organisms to be found in its shelter. It is easy to obtain information about the Gorse itself, but information regarding its inhabitants is harder to obtain. Much is only in technical publications, and most of these are not readily available. It is my aim to present this information to you in the following pages.

The Gorse Plant Itself

The Gorse is the common moorland furze of England. It was introduced very early into the South Island as a hedge plant. As such it was and is very useful, but unless kept cut well back it spreads very rapidly. Because of this it has been declared a noxious weed.

It is one of the Pea family of plants and has the nodules of nitrogen-fixing bacteria on its roots. Because of this it can do reasonably well in comparatively poor soil. It has small simple leaves which are only noticeable on a young plant, or in a very moist area. In most adult plants these leaves are almost entirely absent. Their place is taken by green spines, which develop a very thick skin as a protection against drying out. This means that the gorse can stand quite dry conditions, and it has done well on many dry clay hillslopes. The spines serve another function in that they give appreciable protection from heavy grazing.

The gorse flower is of the Pea type, with pistil and stamens protected within a keel. The petals forming this keel are kept together at their lower edges by a fringe of hairs. The flower is an explosive type—the pistil and stamens thrusting up from within the keel when an insect alights. Having once been sprung they remain exposed, and the petals begin to wither. Pollination is carried out by the curled pistil striking the insect's abdomen, collecting pollen from it, and moving forward out of the way of the stamens, to prevent accidental self-fertilisation. The flowers produce no nectar, and have no lines or other devices on the petals leading to the nectaries. The pod is like that of other legumes, except for the presence of a diagonal band of material in each half that contracts on drying and twists the halves open with a snap.

Life in the Gorse Patch

When one thinks of a briar patch or a gorse patch one's mind turns to Uncle Remus and his tales of Brer Rabbit. It is true that the Rabbit is one of the fewer larger animals that can live comfortably in—or should we say under—such a prickly home. It is probable that no other mammal will be found in the heart of the gorse patch except for an occasional hibernating hedgehog in winter. The dense growth and spines are very effective in keeping the gorse patch undisturbed by larger animals. This fact makes it the ideal home for hosts of smaller animals. Being often on a dry hillside, various species of lizards—both skinks and geckos—may be found in some districts. A good description of these can be found in Martin's "Fauna of New Zealand".

In the dry grass under the bushes Grass Spiders and Wolf Spiders can be found, as well as various type of beetles. On the branches and flowers a number of insects—Ladybirds, Aphids, and Weevils—are usually active, while Crab Spiders lurk behind many of the flowers. Running over the rough bark of the stouter branches and short trunk are various Leaping and Chink Spiders, and the well-known Harvestman. Beautifully marked Orb Web Spiders spin their wheel-like webs between the spines or lie in wait behind their snares, while the untidy silk traps of Tangle Web Spiders spread from branch to branch. In summer the growing tips of many branches are cloaked with the silken nests of the Nursery Spiders. Flying over the bushes are numbers of bees and flies which move from flower to flower, and sometimes become entangled in a spider's web.

Vegetarians and Meat Eaters

Life in the gorse patch is fraught with danger for most members of the community. Although larger animals are excluded, and life is fairly safe for the Rabbit, most of the smaller creatures are constantly at war. The gorse itself it attacked by vegetarians like the Weevils and Aphids, and is visited by the bees which want pollen for their "bee bread".

These vegetarian members of the community are hunted and trapped by the meat-eating members—the ladybirds and spiders of various kinds, and if a spider of another kind gets caught in a web, it too is eaten. These predators are not completely safe, for any lizards present will make a meal of an insect or a spider. Even the active flies and bees are caught out, for they often blunder into webs spread between branches, or are caught by Crab Spiders concealed in the petals of the flowers.

Glimpses of the Inhabitants

1. *The Insect Group*

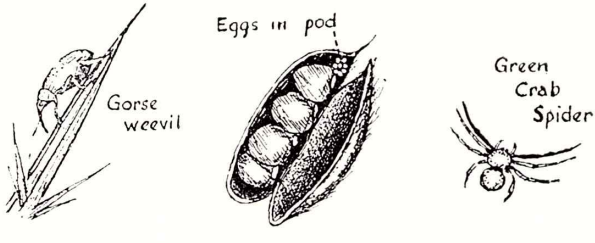
A surprisingly small number of insect families live on the gorse bush. Only three families are represented. They are the Weevils, the Ladybirds, and the Aphids. The Weevils and Aphids are vegetarians living on the gorse bush itself in all stages of their development, but the Ladybirds in both larva and adult form live on the Aphids.

Weevils. The largest family in actual numbers is the Weevil family. Two types of Weevil are found on the gorse bush, one being a native New Zealander, and the other an assisted immigrant. The New Zealander is a brownish Weevil nearly $\frac{1}{4}$ in. long with a broad blunt snout and lighter markings on the wing covers. It appears to live on the young spines and leaves. Very little is known about it, and I do not yet know where or how it breeds. Its name is probably Tigones gracilis.

The immigrant is an entirely different proposition. It is the *Gorse Seed Weevil* (Apion ulicis). This is a small, greyish weevil with a long rod-like snout. Its total length is 3-4 m.m. The greyness is caused by the presence of numerous fine scales all over it, which apparently sometimes rub off. This means that occasional individuals are found that are almost black. The long rod-like snout is used by the female to drill into a young seed pod and form a hole through which she can lay her eggs. The only other plant to be attacked at all by this weevil is the common broom. This fact makes the Gorse Seed Weevil an almost perfectly safe biological control for gorse, especially as none of its natural enemies is present in New Zealand.

Its introduction was through the Cawthron Institute, Nelson. In 1927, they imported a small consignment from England, and proceeded to carry out very thorough tests of the insect's habits and suitability. By 1931 they were confident enough to proceed with liberation. A list of places where the Weevil was liberated can be found in both a Cawthron bulletin and a Journal of Agriculture article (Oct., 1947).

The Weevils' Job. The Weevils control the spread of gorse by the destruction of developing seeds—not of growing plants. The adult weevils live on the leaves and petals, and, to a certain extent, on the surface material of the spines. As the young pod begins to develop from the fertilised flower the female weevil drills a hole through the pod. Through this, she deposits her eggs in little clusters beside the developing seeds. The hole closes up and seals the eggs inside by natural growth. These eggs hatch into tiny curved grubs that proceed to eat the young seeds. Some time later they pupate, and then hatch as adults—still within the sealed pod. These adults can live for some time within this closed pod. They are finally released when the pod dries and twists open. Dr. Miller reports that the number of weevils in a pod varies from one to sixteen. W. M. Davies found in England that three of the insects could account for all four to seven seeds in the pod, but the same amount of food was enough for the development of up to 16 weevils.



In winter the adult weevils may be found sheltering at the base of buds and spines, looking like tiny grey buds. On a warm day they may become active enough to feed on spines or leaves—or

flowers of the autumn flowering. In spring they become very active, eating young shoots and leaves and, later, making large holes in the petals of the spring flowers. Eggs begin to appear in the young pods in late September. The eggs are in little clusters; they are yellowish, and glisten. The position in the pod varies greatly. Do not be deceived by the creamy white aril on each seed. (See diagram — "Nature Study Handbook" — Beggs, p. 117.) Four weeks later the eggs hatch into grubs which attack the young seeds. Some six or eight weeks later these pupate for two weeks. At the end of these two weeks the adults emerge and await the explosive opening of the pod which will scatter them over the gorse patch.

"Sap Suckers"

Aphids live by sucking the sap from plants. Their mouth parts are built like a hollow needle, which is plunged into the sap vessels of the plant. During winter months tiny winged insects, often with wings much longer than the body, can be found sheltering under twigs, spines, and leaves on the gorse. These are the females of what are probably several kinds of Aphid which only winter on the gorse.

The most commonly found "sap sucker" is, once again, an immigrant. She is an Australian, and is often found as a pest in orchards. This is the *"Cottony Cushion Scale"* or *"Fluted Scale"* (Icerya purchasi), which sometimes attacks gorse. A good account of this insect is found in Dr. D. Miller's book on "Garden Pests in N.Z."

"Niggers and Scarlet"

The third insect family is well known for its bright colours. Most Ladybirds are dressed in scarlet and black and they and their brownish black larvae—"niggers" to the children—live on Aphids. An excellent article on Ladybirds is found in the Nature Study Bulletin, Vol. 4, No. 3, written by W. S. Jones. A description of the Ladybirds mentioned below is also found there.

Many Ladybirds are distinguished by the number of spots on the wing covers, as may be observed in the names that follow. Four kinds of Ladybird were found commonly on gorse. They are the *Eleven Spotted Ladybird* (Coccinella il-punctata), the *Seven Spotted Ladybird* (Coccinella septempuctata), the *Two Spot Ladybird* (Adalia bipunctata), and the *Crimson Ladybird* (Vedalia cardinalis). This last Ladybird was introduced into New Zealand from Australia to control the Cottony Cushion Scale in orchards. It is found wherever the scale is present on gorse.

2. *The Spider Group*

A surprising number of Spider families and groups can be found in the gorse patch, from the very tops of the bushes to the ground immediately beneath the bushes. Many are large, some are very small. Some are plain black or brown, and some are

patterned in striking colours. Some are master architects building geometrically perfect webs, while some are "Jerry-builders" who throw the web together in any sort of order, and some never build webs at all. Here it is that true variety of form and habit appears in our gorse patch community. All the features of interest mentioned below can be seen, or seen more easily, with the aid of a hand lens.

The Architects

All the *Orb Web Spiders* are rather large for spiders and have large abdomens. Many are dull coloured—grey or black, sometimes brown—but some have beautiful markings on the upper surface of the abdomen. These markings and variations in shape of abdomen or legs are identifying points of the various species, but as there are a great many known species in New Zealand and almost certainly more unknown, it is not an easy or profitable task. One thing that can be noticed with the Orb Web Spiders is the shape of the abdomen. Many have a distinctly triangular shape—the broad part forward. These are members of the genus *Aranea.* One with a bright green leaf shaped marking is fairly common and is called *Aranea viridata.* One with a squat hunched up abdomen much higher than the cephalothorax is called *Leucage dromedavia.* Others have a long cylindrical abdomen, and one, called *Orsinome arborea,* is distinguished by having the first pair of legs much longer than the others.

Some Orb Web Spiders wait for their prey in the centre of the web itself. Others, the Araneas for instance, have a "telegraph wire" from the centre of the web to a hide-away behind a convenient bunch of spines or in the angle of two twigs. When some insect blunders into the web the owner dashes out, binds the intruder in ropes of silk, and then drags it back to its hidden lair to be sucked dry and then discarded.

The life span of most Orb Web Spiders is about one year. The tiny webs seen in spring and early summer belong to youngsters, while the large webs of autumn belong to mature females. During winter months few webs are seen or occupied. Most of the females have begun to spin a spherical silk cocoon in which to protect their eggs, that are laid in late autumn and early winter. When the eggs are laid and the cocoon spun the exhausted spider dies. Cocoons of the different species vary greatly in structure, appearance and placing. The spiderlings emerge in spring and summer and disperse by means of "gossamer" floating in the breeze.

Jerry Builders

Amongst the lower branches of the bushes or further in towards the centre there are other webs which run in all directions and, although appearing untidy, are designed to trap insects ascending from the ground or descending through the bush. Although these

webs appear to be formed of many lines running haphazardly without plan, there have been discovered recently several such webs with unsuspected features (see Crompton). Very little is known about the New Zealand species that spin this kind of web, so there are great opportunities for original observation.

Most of these *Tangle Web Spiders* are members of the genus Theridion. They are mostly small and quite brightly decorated. One—*Theridion veruculatum*—has a black margined leaf-like yellow mark on a greyish abdomen. Close relatives are found in sheltered corners indoors. Another relative—although not so close—is the Katipo; there is more than a hint of its relationships in the tangle web it builds under driftwood and debris on beaches.

The Hunters

There are two distinct types of spiders on the gorse bush that live by hunting rather than by building a snare. The first lies in ambush awaiting unsuspecting insects, while the other engages actively in the chase and stalks its chosen victim.

The first is the *Crab Spider* which lurks on flowers or behind foliage. Many crab spiders are brownish or yellow, and lie in wait on flat or basin like flowers until a bee or fly alights. The flowers of the gorse are obviously not suited to this kind of ambush, so the Crab Spiders of the gorse bush are normally found on the young spines, or in the stem just behind the flower. Their colour—not surprisingly—is green or yellowish green. Other than by the colour one can identify the Crab Spiders by the position of the legs. In all other spiders at least the front pair points forwards, whereas in the Crab Spiders all four pairs point sideways. (See diagram on page 10.)

The other hunters are members of the *Jumping Spiders* or Leaping Spiders. These are usually fairly small, with comparatively long legs. Their eyes are arranged in three rows—four, two, and two—with the centre two eyes of the front row largest. These spiders hunt over the trunks and branches of the gorse bush relying on their sight, whereas the web weavers rely on touch. When an insect is seen it is stalked in little rushes ending in a leap on to the unfortunate insect's back. When shelter is required most species rely on crevices and gaps in the bark of the branches.

One of the commonly found species is a little, elongated, cylindrical spider having a yellow stripe right down its back. It is called *Trite planiceps*. Another rather flattened spider which is completely black is often found. It is probably *Holoplatus senilis*.

One of Nature's Nurseries

A spider distantly related to the Jumping Spider is *Dolomedes minor*. This is well known as the Nursery Spider. This active inch long, brown spider hunts over the bushes and ground immediately surrounding them. Sometimes a female will be found running around with a white bag of eggs clutched tightly to her. This

white cocoon is later attached near the tip of a twig or branch and swathed around with sheets of silk—the only silk this spider produced except for the egg bag. Sometimes mother can be found clinging to the outside of this nursery, but more often not. The spiderlings hatched out in this nursery are released by the growth of the plant ripping the silken walls apart.

Mother Love

Below the gorse bushes another set of spiders can be found. One type is apparently a nomad, and the other sits at home in the centre of an ingenious web. The "nomad" is often not really such a roamer as there is likely to be a hole in the ground, or a sheltered spot under a stone that forms a permanent home. The nomadic appearance is occasioned by the constant hunt for food in which these swift footed Wolf Spiders engage. They carry their egg cocoons around attached to their spinnerets, and when hatched they carry the young on their backs for some weeks, after which they join the throng of other spiderlings floating through the air on their gossamer strands.

One or two species of Wolf Spider may be worth noting. The common, brown, half-inch spider with a light yellow stripe down the back is called *Lycosa hilaris;* it belongs to the same genus as the fabled Italian Tarantula (*Lycosa narbonnensis*). A large reddish brown spider over an inch in length is sometimes found running over the ground. This is probably the wandering *Uliodon frenatus. Dysdera australiens* is an unmistakable Wolf Spider. It is just under an inch long with bright red legs and cephalothorax and a rather flesh coloured abdomen.

Exit Provided

The web building ground dweller actually builds its web in the dry grass—and so can be called the *Grass Spider.* It is one of the large group of Funnel Web Spiders that are found in many habitats. This web is a rough kind of platform of tangled threads with a funnel shaped tunnel leading from the centre of the web down into the grass. The Grass Spider waits in the mouth of the tunnel ready to pounce on any unfortunate insect that alights on the web, or to drop down the bottomless tunnel and hide in the grass if anything startles it. This spider is probably a member of the genus Tegenaria.

Spiders' Cousin

Another "spider" often on the gorse bush is the very long-legged *Harvestman.* This is not a true spider, although a member of the Arachnida. They are members of the sub-group Phalangidae. They can easily be distinguished from the spiders in that there is no clear division of the body into two parts—the cephalothorax and abdomen. They, of course, do not spin webs.

Visitors on the Wing

A number of insects are commonly found about the gorse patch, but do not make their homes there. They are the various flies and bees found flying over the bushes or on the flowers. What exactly attracts the flies seen I do not know, as there is no nectar secreted by the flowers. I have not seen them on the flowers themselves, and doubt that their weight would be sufficient to operate the pollinating mechanism if they did alight. Both hive bees and bumble bees are regular visitors to the flower, however, for pollen with which to manufacture "bee-bread". Both of these types are probably effective in pollinating the gorse flower.

The ordinary Honey Bee is well known and needs no description. Nor do the Bumble Bees, but if one desires to know which of the three species in New Zealand one has, there is an excellent article on their identification in the Nature Study Bulletin (Vol. 3, No. 2), by K. M. Doull.

Flies of the types known as *Hover Flies* and *Drone Flies,* have been seen and identified. Others may be found in other districts. The tiny Hover Fly, *Syrphus novaezelandiae,* may have been laying eggs, as its larvae live on aphids. The flies of this family are brightly coloured, and often are mistaken for bees or wasps. When flying they have the habit of hovering for a few seconds and then darting on again. The larvae of many species are aphid eaters, while the adults live mainly on nectar. This seems to indicate that the purpose of their visit to the gorse patch was primarily to lay eggs. The smaller species of this family are generally known as Hover Flies, while some of the larger and more bee-like species are called Drone Flies.

What the Class Can Do

Most of the insects in the Gorse Patch Community are rather small for observation by younger children. Much can be done however by seasonal visits to discover the various stages of the life cycle of the Gorse Weevil in the pods. On these occasions a suitable number of pods can be opened to watch the development of the cycle. Nature table displays of the Gorse Weevil are best; use small plastic boxes or glass jars. The weevils are so small as to be lost to sight in a conventional insect box. The aphids can be left on the young shoot and displayed either in one of the above containers, or in a vase of water. They move so little that there is little likelihood of their being a serious nuisance on the nature table.

Most of the spiders are large enough to see. The best place to observe them is, of course, outside at the gorse patch, but all can be brought inside for team observation or nature table display. They can all live for some time on no food, but they are easily fed on flies, midges, or any other flying insect. Many spiders however will not take bees, and wasps, or coloured insects like ladybirds. The hunting spider types can be fed on suitably sized beetles, flies,

or even the Gorse Weevil itself. Several spiders should not generally be kept in one container; they will kill and eat each other.

Collecting methods are simple. The quickest and easiest for the flying insects is a butterfly net or some similar contrivance. For all those insects found on the bushes use either a cardboard box with lid, or a sheet of white paper or cloth, and a stick. The cloth is placed below the selected bush, and the bush is then shaken by hitting it with the stick. This shaking will dislodge a large number of spiders and insects, many of which will "play dead" for some few seconds. This time is ample for a good selection to be made.

A Wealth of Topics

The actual work done by the class will depend largely on the grade, but also on the area and the other topics planned for study during the year. The Gorse Patch can supply a wealth of topics for various classes. It can provide for topics and units of work varying in complexity from one or two lessons and a field trip, to a seasonal study lasting throughout the year. It can be tackled from the point of view of the plant—an interesting home for a host of creatures. The study could be of the Gorse Weevil—its uses, life cycle, and enemies. For Form 2 a unit of work on biological control of a noxious weed is available. A whole term could be spent studying the spiders alone, and their various adaptations to their environment.

Many other suggestions could be made, but the decision as to the right topic and the right approach for your class must be left to you, the teacher.

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New Zealand Flax as a Host

J. B. Dickson

Phormium, or flax, serves as a host to a number of insects, all of them with interesting life histories which children find pleasure in elucidating. If flax bushes are common near your school a good unit of observational nature can revolve about them, with nature table exhibits, field work, and team discovery all adding their quota of interest and activity. It is my experience that some insects can be found on flax all the year round; but for a study which includes life histories the most suitable time to commence the project is early spring.

The insects have been set out in groups, e.g., Leaf Insects, Gum fluid Insects. This enables each group to be taken observationally as a sub-unit of the larger whole. By concentrating the children's attention on insects which live together in communities, we give meaning and system to our explorations.

Flax as a Host

There are two species of phormium—see This Month's Plant, N.Z. Flax, Nature Study Bulletin, Sept., 1955. Mountain Flax is the smaller of the two and has yellowish flowers and long, twisted, pendulous seed capsules. Young shoots arise from the centre of the plants, so that the outer leaves of the fans are the oldest; they commence to die off at about $1\frac{3}{4}$ years. When withering, the leaves turn inwards along the edges and in time form a hollow tube. These "leaf-tubes" harbour insect stages, spiders, and other animal forms. So, when looking for a suitable bush on which to commence operations, ignore the well tended and carefully cultivated bush of the private or public garden—although these are not without their insects. Look rather for the straggly, neglected bushes, which have their green leaves eaten and dead leaves accumulating about the base of the plant.

The fans formed by the packing together of the folded leaves provide both shelter and foraging for insects. The top third of a young leaf is good eating; the lower portion, in close contact with its fellows, and secreting large quantities of gum fluid, provides both shelter and food.

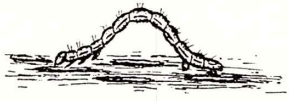
Those Leaf Notches!

Few of us have failed to notice the "windows" and the "notches" which give flax leaves that very moth-eaten appearance. They are the work of two secretive caterpillars, which feed by night and hide by day.

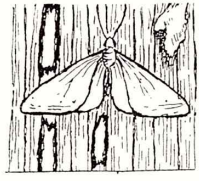
The Looping Caterpillar—"Windows": Most caterpillars have five pairs of tube feet which support the middle and hinder parts of the body. Loopers, the caterpillars of geometer moths, have only two parts. The middle part of the body is bent into an arch support, and the caterpillar loops along, with back hunched.

The Moth (*Orthoclydon praefactata*) is found throughout New Zealand, even on mountain flax at a height of 4,500 ft. It is snow-white, but the wings are minutely dotted with grey, and ornamented with rows of indistinct lines near the margin. Though conspicuous, it resembles the white flakes of dry flax gum. During the day, it shelters amongst the denser foliage, going abroad at night.

The globular *eggs* are laid in batches of 1 to 90 on the back



The Looping Caterpillar



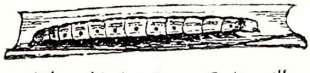
White female moth

of the leaf. At first they are green, like the leaf, but they become reddish within 36 hours, and rich-red in five days because of the red stripe on the back of the caterpillar developing within.

The Caterpillars, on hatching, are a transparent yellow with a central dark-red stripe, and a large head. At once they attack the lower leaf surface, leaving narrow, indistinct cuts, which become gouged-out patches as the caterpillar grows. For a week it is the colour of its food—a bright green. It grows into a yellowish looper, with rich-red stripes, feeding at night and sheltering through the day between leaf bases or in leaf tubes. Its flattened shape helps it in these cramped hide-outs.

Then come the *pupae*—those from the first brood of caterpillars in February, others in March or April. They are to be found in earthen cocoons, about two inches deep in the soil, or sometimes between dead leaves. If you find some, keep them in a jar or insect box, and watch for the moth emerging.

The Notching Caterpillar—"Saw-edges": This larger caterpillar, with its bigger moth, straddles the leaf-edge at night, eating out whole pieces, both fibre and leaf-green, in the shape of a V.



The Notching Caterpillar

Its moth

The Moth (*Melanchra steropastis*) is one of the noctuids, dull-coloured, night-fliers which rest in dead leaves and refuse through the day—and are coloured and streaked to resemble these hiding-places. They are therefore very different from the conspicuous white moth of the "looper", and, unlike it too, rest with brown wings folded tentwise to cover the back. They lay white *eggs.*

The Caterpillars, with a full count of tube feet, are "crawlers", not "loopers", often pinkish, and stencilled with fine black lines. They will be found, readily enough, within the leaf-tube of recently notched flax, some of them very large—up to $1\frac{1}{2}$ inches long—and filling the diameter of the tube. They may even be found in clumps of toe-toe grass.

The Pupa is shiny brown, in a dry soil-cell, like that of other noctuids.

Other Leaf Dwellers will usually be found, some in one district, some in another.

Sap-suckers are insects with delicate stylets in place of jaws. They connect with the sap vessels, and the withdrawal of sap causes yellowing of the leaves. *Leaf Hoppers* (the brown Passion-vine Hopper or the Green Leap-hopper) are winged, like blunt-headed moths, but jump rather than fly, when touched. They have a quaint growing-up stage, a fluff-tailed nymph, which also sucks sap and jumps. *Scale Insects* suck sap and sit still covering themselves with a protective armour, either cottony or hard. The Mussel Scale and the Cottony Cushion Scale are two found on flax. They are described in *Miller*: Garden Pests in N.Z.

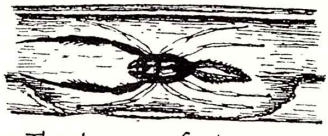
The Casemoth is frequently found on flax, building its case from bits of leaf which it cuts away. It is dealt with in the Nature Study Handbook.

The Blue Damselfly, which lays its eggs in ponds, sometimes makes puncture marks for its eggs in transverse rows on flax leaves.

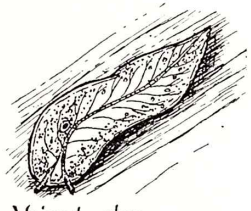
Look for Things in the Dead Rolled Leaves!

Caterpillars are not the only living things that make homes in leaf-tubes, and fare forth to feed.

Leaping Spiders, active and alert, will leap from their leaf lairs as these are opened. If one is discovered cut the leaf cleanly at either end of the lair and place it in a jar to avoid losing its agile occupant. Fed on flies, it makes an entertaining classroom pet. Its white silken nursery may be filled with young or eggs.



The Leaping Spider in a leaf tube



Veined slug

Tunnel-web Spiders are stouter and less agile. Usually they will be discovered as a moving bulge within a silken tube.

Look in the Gum Fluid which gathers at the base of the leaves.

The Veined Native Slugs, illustrated above, may be found. The moist situation is much to their liking, and their remarkable aptitude for flattening themselves into leaf-like transparencies enables them to travel where others would not dare to dwell. See "Native Animals of N.Z." (Powell).

A Rat-tailed Maggot. Breathing becomes a difficult matter for an insect living in gum fluid. The larva of the Drone Fly—a bee-like insect very common on Michaelmas daisies and other garden flowers—solves the problem with a tail-like, telescopic breathing siphon which can be thrust through the surface like a periscope. Larvae in all stages of development may be found throughout the year, feeding on the gum-fluid. I kept some under observation for over three months before they pupated—and they were fairly large specimens when they were collected—so the larval stage may last for five months or more. When full-sized (about $\frac{1}{2}$ inch) they crawl on to the dead leaves and transform to a pear-shaped pupa covered with a greyish-white powder from the dried gum-fluid—and still with a tail. From this the shiny black drone fly emerges by a circular opening in the broad end.

The Chironomid Midge. Swarming in the gum-fluid, tiny, worm-like midge larvae may be found. They swim with loopings of the body, and attach themselves to the leaf-butts to pupate. The midge that emerges is minute and perfectly black, with densely plumose feelers.

The Predaceous Hover-Fly Larvae are close relatives of the drone-fly larvae, but have no tail, and feed upon the small midge larvae, not on the gum-fluid. They also crawl over the leaves, slug-like after the manner of an army tank, in search of the looping flax caterpillar. They pupate on the dead leaves in club-like striped cases, and the $\frac{3}{4}$ inch long hover-fly which emerges (*Syrphus ropalus*) is brightly coloured with orange-yellow bands and spots on a black background. For classroom purposes, this insect has an advantage over its relative in its shorter life-cycle.

The Seed-pods are Hosts

A moth common in gardens, and attracted to the window-panes of houses at night, is nurtured, in caterpillar-hood, within the seed-pods of flax. Its active larva joins the ripe seeds of autumn together with silk, and lives in the pods through the winter. It is chocolate brown with black shiny head end, about $\frac{1}{2}$ inch long. In November, the pretty *flax pod moth* (*Stathmopoda phlegyra*) *emerges,* about $\frac{7}{8}$ inch across the ochreous-yellow to grey forewings, and grey hindwings.

In North Island districts another flax-pod moth (*Erechthias terminella*) rears its caterpillar on ripe flax seeds. This black diet makes its intestine show dark along the length of the straw-coloured body; and the moth appears in January, its dark-brown forewings ornamented with a cream-white streak.

Insects Attack the Roots

The thick fleshy rhizome of flax makes good feeding, and another sap-sucker is generally found associated with it. The clue to its presence is the empty ghost of a nymph case found somewhere about the plant. From it has emerged the cicada of the open country. *Melampsalta cruentata.* It lays its eggs in a herring-bone pattern of punctures or slits marked by damaged fibres protruding from the scars. The tiny nymphs which emerge drop to the soil and build tunnels amongst the roots, from which they drink sap. If they escape death at the hands of carnivorous ground beetle larvae, they will emerge from the soil in about two years, climb the flax plant, and, splitting their shells, transform into winged cicadas.

The Biters Bitten

The story of flax insects would not be complete without mention of the attackers' enemies, the flax-grower's friends. The Predaceous Hover Fly is one. Others are Ichneumon Wasps, and a parasitic fly.

Ichneumon Wasps lay their eggs within other insects. They are narrowly-waisted insects, often brightly coloured, active, with sensitive vibrating feelers. The female carries a sting-like ovipositor behind her body, and this is thrust into the hapless caterpillar, leaving an egg; the grub which emerges feeds on the inside of the caterpillar. One such wasp (*Paniscus productus*) is half an inch long with jet-black body and head, a golden bar across its abdomen, and golden coloured legs. It may be seen scrambling over flax leaves in search of the windowing caterpillar. Its grub lives in the caterpillar without killing it, pupates within, and the winged wasp eats its way from the moth pupa, now an empty shell.

Another smaller ichneumon, about three-sixteenths of an inch long, lays its egg in the same caterpillars, pupating and killing them, when they are about half-grown. This usually happens within a leaf-tube, the dead caterpillar now glued to the leaf by a glutinous substance which exudes from its tail-end. The ichneumon wasp emerges from a circular hole which it cuts in the upper side of the old caterpillar skin.

The notching caterpillar also has its enemy, the parasitic fly, *Phorocera marginata.* So far I have not been able to locate this fly or find an account of its doings. You may be more successful than I.

Class-room Methods

On commencing a unit of work on "Flax as a host", the need —as with any lesson—is to arouse the interest of the class. This can best be done by arranging a display of flax, and insects inhabiting flax, on the class nature table. Not a few short blades in a vase, but if possible a fan complete with seed head. Care should be taken to select a fan which has been attacked with flax

caterpillars. Display also caterpillars, pupae, or moths of the insects responsible for the damage. Information and question cards may then be pinned to the notice board, and cotton used to connect, for example, the notching on the flax leaves with the notching caterpillar.

The above is only a suggestion and by no means the only method. You may prefer to commence your observational study with a field trip to an adjacent field of flax. In whatever way this study is undertaken, I suggest that to be successful, methods must include the fullest use of nature table, field trips, and group lessons.

Lesson One may well start with the plant itself. The uses made of the flax-plant by the Maoris, early settlers, and traders, and its use to-day, provide an excellent link with social studies. (*Bulletin* 3, Vol. 5.)

Lesson Two—though it should be clearly understood that any one topic may extend over a period of two or three weeks—could cover the flower, pollination, and seed dispersal, linking the plant with native birds, certain species of which visit the flowers to obtain nectar. On the other hand, if you commence a study of flax in the early spring—a good time to begin—flowers will not be present, so this lesson would have to be taken later.

The above lessons should be taken near flax-bushes, or in groups in the school with the material available.

Undoubtedly, as the children are examining the flax in these early lessons, they will discover various insects, particularly if a display of these has been arranged and attention drawn to them on the nature table. The order in which these insects are observed is not really important, and it is by no means necessary to follow the pattern set down in this article. I shall, however, commence with flax-caterpillars, since first of all attention has been drawn to their attacks in the suggested nature table exhibit, and secondly because the insect and the damage caused by it are so obvious to the searcher.

Lesson Three will then cover caterpillars. It is obvious that this lesson will comprise a week or two of work. In fact to watch the complete cycle of the notching caterpillar for example, will require two months or more, since pupation alone takes just over a month. This can be done by placing caterpillars on the nature table to pupate and emerge while the series continues.

In order that the class observe the structure and locomotion of these caterpillars, children should be arranged in groups. I have found that clear, glass, marmite jars are cheap and useful for the handling of caterpillars by groups.

Following on naturally after caterpillars, would come predators and parasites—insects which help us to control the flax-caterpillars. There are four of these listed in the article, two Ichneumon species, and two predaceous larvae of flies. These four may well be observed and compared together under some such heading as

"Insects which help us", since although all four lessen the percentage of adult moths, all are not of equal importance, and all four have different methods and stages of attack.

Now some of these species may not be readily obtainable just when the class is ready to begin observational study. Therefore I suggest that the class keep a look out during the earlier field trips, particularly for the Ichneumon species. I have seen and caught the larger species on several occasions, but to capture the smaller species, it is usually necessary to search for the parasitised larval cases of the windowing caterpillars, which, with the parasites inside are to be found glued to the inside of the dead flax leaves. These parasites will emerge if kept on the nature table. Some interesting work can be done by introducing these parasites into an insect box in which there are some young caterpillars, thus affording an excellent opportunity to observe the life-cycle.

Next we come to gum-fluid insects. These are particularly suited as subjects for field trips, since one can be almost sure that any flax leaf will contain some, if not all the species mentioned. When searching for these insects, a sharp knife or secateurs are essential. By pulling the leaves apart at the base of the fan, a quantity of fluid in which these insects live may be seen. Cut the leaf off close to the ground, endeavouring to retain as much of this fluid as possible. At times the insects may be found some distance up the two sections of the leaf which is cemented together.

A good method of transporting these insects from the field to the class-room, is simply to cut off a piece of flax from near the base of the plant. With the insects living in the sap between the two folded sections of the leaf, an excellent container is provided. If, however, a group work lesson is being conducted while on a field trip, pieces as above may be cut off, opened up and given to the various groups to observe—this works very well.

For long term observation in the class-room where the aim is to observe the life-cycle, it is much better if these insects are placed in small, clear, marmite jars, with two small pieces of flax lying fleshy side down on the bottom of the jar. A few drops of water will provide the necessary damp conditions. It is interesting to allow the children to cover the rat-tailed maggots with water in order to observe the workings of the telescope-like siphon. Do not leave the insects in too great a depth of water; better results are obtained as described above. Most essential is the provision of a piece of dead, dry flax, placed vertically in the jar, since the insects require a dry surface up which to crawl and pupate.

The above condition will allow rat-tailed maggots to be kept for months. The predaceous larvae, if small, will need some food. I found that a pupa of a flax caterpillar provided enough food to pupate the predaceous species. Actually it pays to collect full grown larvae as the larval period is fairly lengthy, ranging from one to four or five months.

Some Difficulties, and How to Overcome Them

In attempting to keep flax insects in the class-room there are certain difficulties which may not at first appear obvious. For example, the flax caterpillar feeds at night, is sensitive to light, pupates under the ground at a depth of two inches, and may turn carnivorous if kept in the same box as the pupal stage—quite a problem child.

Because of the sensitivity to light, I have found that the ordinary insect boxes are not exactly suitable, since the caterpillars will crawl up into the dark corners of the roof, or hide behind a piece of leaf and remain invisible. An ordinary Agee preserving jar, lying on its side, is ideal. If possible the jar should be placed on a stand to prevent it from rolling, and two or three pieces of flax placed within. Thus even if the caterpillars crawl under the flax, the jar can be lifted for observation.

The pupation difficulty can be overcome by placing some cotton wool in the bottom of the jar. The caterpillars will burrow into this material using it to construct a cocoon. Once the larval skin has been shed and the pupal case formed, it is advisable to remove the greater part of the cotton wool since the emerging adult tangles in it and dies unless freed.

A better method is to provide pieces of half decayed, dry leaf from near the base of the plant, and the caterpillars will use this material in the construction of their cocoons. Once the cocoon is formed the teacher can remove a portion of the cocoon in order that pupation may be kept under close observation.

Take care to remove any pupal stages from containers which also house large caterpillars since as already stated the latter may eat the former. I think that the problem here is really one of fresh food. So far I have not been successful in getting caterpillars of medium or full size to eat in captivity. The average insect box is too small to allow adequate space for flax, and furthermore flax seems to dry out quickly and become toughened when cut. I have tried other food plants. Spinach appears to be acceptable to some of the caterpillars.

Conclusion

The present article has by no means exhausted flax inhabiting insects. Many more remain. Included amongst these are, Trap-door and other Spiders, Shield Bugs, Beetles, Snails, Flatworms, and Cockroaches. Those dealt with will, however, suffice to introduce the interested ones to a unit of work which if carefully planned and organised, will provide interesting, and helpful observational nature study.

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Two Sample Studies in City Schools

An Area Study in the Grounds of a City School

A. J. Bennington

There is an increasing emphasis on area studies in Upper School classes. This article tells of a study carried out in a large city Intermediate School, where one hour per week was allocated to Nature Study. The grounds of this school could well be considered typical of a large number of schools, with the usual utilitarian flower-beds, specimen trees at intervals, an overgrown vegetable garden, and a sportsfield and grass area; the whole enclosed by a Golden Ake-ake hedge, by wire and paling fences. A belt of large untrimmed macrocarpa trees at one end of the playground appeared at first sight to be the only place with real nature study potential; so it was here that we started.

First, a Practice Run by the Whole Class

In the preliminary lesson it was explained to the class that the study of the macrocarpa belt would essentially be on the individual level, but that it would show them how they were to conduct their group studies of the various areas in the playground later on. Ecology, or the inter-relationships of plants, animals and environment, received emphasis from the beginning, since an understanding of this aspect is the basis of a successful Area Study.

For our first visit to the macrocarpa belt the class was divided into four groups, of approximately ten pupils per group. Each group was apportioned an area, and within its bounds they were to find and collect one specimen of each type of animal (insect, spider, etc.). They were given 15 minutes for the job. Then they conferred briefly in order to sort and identify their specimens, and to ensure that each animal had some of its usual food and a fragment of its outside "home" with it. Reporting back by the groups followed. This was done outside, with all the pupils seated on the grass facing the group leaders who in turn identified and described the animals and gave an account of the "home" or habitat in which each was found. The group which collected the greatest variety of specimens was then appointed to set up jar terraria or insect box "homes" for their animals, these to be displayed along with a list of their names, on the Nature Table.

Recording for this field trip was done in the pupils' Nature Study books. It consisted of a small but accurate drawing of each specimen, with its name, where it was found, and any interesting features or habits which may have been observed.

As soon as all books were satisfactorily completed, a second field trip to the macrocarpa belt was held, this time to discover the plants of the area. A similar procedure to the first trip was followed for this one except that it was preceded by a discussion

on how to collect, press and mount plant specimens. The children each made a labelled collection in their books.

The next lesson concluded the macrocarpa belt study. It took the form of a discussion on the interdependence of the particular plants and animals that had been found, and resulted in the building up of a simple food chain.

Then a Detailed Study in Groups

Having introduced the "Area Study idea" to the class, it was then possible to divide the School environment into the following sub areas, for further study in groups:

1. Sportsfield.
2. Grass area.
3. Shaded area along the paling fence.
4. Golden ake-ake hedge.
5. Grass verge along the road.
6. Flower garden.
7. Vegetable garden.
8. Long grass.
9. Trees of the playground.
10. Shrubs of the playground.

To encourage the idea that the project was going to be a worthwhile one, I suggested that the class would write a book about the Nature Study of the School. So we divided up into ten groups of four children each and each group elected to write a chapter about its area. During the first field trip to their appointed areas each group made a sketch map of their area. They then collected animals and established jam-jar terraria with the animals which they found. Each group studied the material that they had collected; and each person selected two or three different animals, observed them, and wrote a detailed account of their investigations. When this was completed, Group Leaders reported their group's findings and drew attention to their displays and records. It was now time for the groups to tackle the plants of the playground. This entailed group displays on the Nature Table, individual research, and group reports, similar to those described for the animal studies. An editing committee was then appointed to collect all the written material. Since all the records had been made on a standardized size of paper, it was a fairly simple matter to bind it together and then to make a suitably attractive cover and finally to present to the school the class book on the Nature Study of the School Grounds.

Points to Watch

At all times the ecological aspect of the area study must be emphasized both during their field work and later while writing up reports. Books may play an important part in educating. How-

ever, this is one occasion when the teacher must limit their use to identification problems and disallow them for other fact collecting, unless he wishes to find large portions copied into the reports, which are not and never will be Nature Study. Finally, keep the project moving at a fast pace until its completion and you will discover that both you and your class have shared in a most enjoyable and enriching nature experience.

Some Useful Books

Weeds of New Zealand—Hilgendorf.
Common Wild Flowers Series (Pelican)—Hutchinson.
Pasture Plants and Pastures of New Zealand—Hilgendorf.
Garden Pests of New Zealand—Miller.
An Insect Book for the Pocket—Sandars.
The Observer's Book of Garden Flowers—Skene.

An Area Study With a City Class

Justin Hills

I was faced with the prospect of a broken week with a Form I class. Music festival rehearsals, tabloid sports and manual work were all going to result in a proportion of the class being withdrawn at odd times. What could I do? I decided to attempt an area study within the school environment.

The class, consisting of 20 girls and 13 boys was a typical Form I. They were bright, active youngsters who were very curious about me, a new arrival on the scene, and the work that I was to take. They belonged to a new city school where the prospects for nature study appeared to be limited. The children realised this and treated the subject accordingly.

The Situation We Faced

The area that I decided we would study was a piece of waste ground bordering the school property and flanked by one of the city rivers. The dominant growth was weeping willow and elderberry. Weeds and grasses covered most of the ground. Because of the frequency of willow trees it was possible to find a good number of rotten logs with their inhabitants. The river was not very deep nor wide but the banks were steep and in places undercut. This could make study somewhat dangerous. The area that we were to cover was approximately 550 feet by 40 feet. Parts were rendered impassable by growth of such weeds as periwinkle. So much for the area. What of the children? They knew the place so well that they would not be interested—or so I thought. As a class they were fairly co-operative but there were two who caused concern both to the class and the teacher. One boy who is worth mentioning was not at all able at school work

and just could not be interested in the work in hand. "Mr Hills, I am just not interested". So I made him my secretary. This gave him something to do in connection with the project. Another notable child was a girl who had a mental age above the rest of the class and I expected her to turn out a far better job than the rest. Surprisingly, the others produced work of equal quality.

Putting the Idea to the Class

I introduced my idea bluntly by the announcement that we would "do an area study" down the "dip" and told them that I needed two boys with togs to study the stream. This immediately aroused interest in the project and after stating when we were to start and how long we had I left the idea to simmer.

What Happened

On Monday the children arrived with various pieces of equipment, and our "expedition" set out complete with choppers and binoculars. They were extremely interested in the work even though they had attempted a project "down there" before. The fact that they had previously worked unsuccessfully might have detracted from their enthusiasm, but it did not affect them in the slightest.

Setting to Work

First I took the class out on to the rise and sat down facing the area. We talked about the area and individual aspects of it, e.g., the length of time the trees had been there, what sort of animal life that they might find, what would possibly live in the river?

After I had answered questions I gave them the names of the groups (birds, trees, weeds and grasses, animals, creek, rotten logs) they would like to work in. We sorted ourselves into these groups: birds, trees, weeds and grasses, animal, creek, rotten logs and mappers. I then decided that because there was a nature corner we could have a group there and so we added that to the list. After seeing the children in their groups I could see the necessity for some individual studies. The following eventuated: ivy, periwinkle, slater, with editor and secretary added to the list. The latter were the helpers who wrote the preface to the project and assembled the final copy. After they had sorted themselves out I gave them the opportunity of wandering about in the area so that they could see what the other groups were doing—this to prevent them being distracted from their own task when they were supposed to be working. You could almost call it a "free activity" period: it helped them to become acclimatised. In this informal situation, too, I found I could sort out any problem that arose within the groups. This is most necessary for harmony, when some of the groups are not under direct supervision all the

time. It also was the time for me to have a really good look at the place and give the children a demonstration of how to go about their allotted tasks.

My Part and That of the Class

My part in this project was to be, in the words of the children themselves, "their adviser" and my job consisted of "running up and down the track beside the river". I gave them very little actual information. I provided information books, and they looked up what they could not find from observation. *They* actually did the work, I guided and observed. They climbed and looked and collected. They paddled in the stream and caught their specimens. The fact that they were responsible for the work was a very great incentive—the finished work was to be their own.

Writing a Book

This finished work turned out to be a book, each topic making a chapter. This meant that the groups could see their work as a unit and the work of the class as a complete volume. Each chapter was to have a title page, coloured, with a title that would give the reader only a glimpse of the topic, e.g., Rotten Logs became Slum Dwellers. There were to be mounted specimens, where possible, and drawings. They were to write on one side of the page only and the drawings were to be done on a separate page. They were to leave a ½-inch margin down the side of the page and two inches at the top.

The writing of the chapters was done to a plan also. They would start with an introductory paragraph giving their starting date, names of group members and their first impressions of the place. Following this they were to write what they observed and how they observed it. Only then were they allowed to add what they had gleaned from books.

The book itself was to take the common form of title page, index, editor's remarks, map and then the individual chapters. The title was chosen by the children themselves so that they could say that it was indeed their work.

To simplify matters in the writing of the chapter each group chose a leader and an artist as well as the author. This was most successful as they all had a position of responsibility.

The Chapter Headings.

The Editor Interviews, 1; The Map, Weeping Willows, 2; Nature's Carpet, 3; The Thorrington Underworld, 4; High Dive into two feet of water, 5; Nature Corner, 6; Aerial Acrobatics, 7; Slum Dwellers, 8; Up and Over Roundabout, 9; Dental Health, 10; The Armoured Cars, 11.

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